THE TELEGRAPHIC JOURNAL AND

Electrical Review.

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THE MARCHANT ENGINE.

THE tests which we recently made with this engine have been the subject of considerable comment in the pages of several of our contemporaries. Naturally, we have not escaped hostile criticism ; or rather, we should say, in certain quarters doubts have been cast upon the accuracy of our statements. It may, perhaps, be as well to remark that previous to our tests a firm of Liverpool shipowners had made trials with the Marchant engine with even better results than those afterwards obtained by us ; and that the firm, after making other protracted tests, has decided to construct an engine and boiler on this system to develop 1,000 I.H.P., which is intended for use on one of its steamers.

So far it does not appear that we have over-estimated the capabilities of the engine, and we are pleased to see that the *Mechanical World* endorses the very favourable views which we could not do otherwise than express. Our contemporary says :—"It will be seen that by this system the boiler only requires to be supplied with fresh water once, as all the steam and water is continually being used over again. Leakage at the gland and the blowing off at the boiler having alone to be provided for. It is clear that if this can be successfully carried out at sea an immense improvement has been effected in the working of marine boilers. In estimating the efficiency it is not necessary to measure the feed water—as assumed by a contemporary in a recent article on the subject—which is supplied to the boiler once for all, and practically remains constant. The brake horse-power per pound of coal and the indicator cards are sufficient data to determine the value of the work done."

A writer in *Industries*, whilst affecting to disbelieve the economy of coal consumption in the Marchant system, does not hesitate to say that theoretically the inventor has trodden the right path. That portion of his article, however, which deals with the practical working of the engine, is incorrect, inasmuch as it confuses the steam feed with a water feed.

With the opinions of Messrs. Crompton, Massey and Radcliffe Ward our readers are already familiar, so that it is only necessary here to refer to them.

The *Machinery Market*, whose editor has courteously forwarded to us an advance proof of an article on this subject, does not approve of the Marchant engine nor of our tests taken therewith ; but if our contemporary cannot find better means of negativing our figures we do not think they will materially suffer. Says our critic : "Now, we have examined into the claims of the Marchant engine with an unbiased mind, and have particularly looked into the tabular results and particulars of tests, published by the ELECTRICAL REVIEW of 17th ult. Perhaps it will surprise our contemporaries when we state that had the test been applied in what we hold would have been the proper way, the result would have shown a consumption not of ·791 lbs. of coal per horse-power per hour, but nearer 2·373 lbs. Where, then, is the enormous saving ?" What does the *Machinery Market* hold to be the proper way, and how, from our figures, can the writer arrive at the 2·373 lbs. ? Further on we read :—"We could extend our remarks, as well as our decided points of objection to the Marchant engine, so far as any tests or stated results which have yet reached us are concerned. Our readers may hear more from us on this subject later on, meantime we have only to remark that we are unconvinced that there is any substantiality in the claims made on behalf of this engine, and we shall require different results, obtained in quite another way, before we can advise our readers to pay any solid attention to the claims pressed upon them regarding it." Why should our contemporary require *different* results obtained in quite another way ? If the results come out the *same*, or nearly so, when obtained by other methods, we think that there will be no longer room for cavilling.

It will be noticed that although doubts have been raised in certain quarters respecting the performance of the Marchant engine, no valid reasons, either theoretical or practical, have yet been urged to show why such economy in coal consumption is not possible. It seems to us that this, like many another new thing, upsets the theories and reasonings of engineers who never travel outside a beaten track, and who, when the innovation can no longer be ignored or avoided, are driven to the direst extremities to carry on an argument. It must also be remembered that the working steam pressure of 250 lbs. is in itself conducive to economy in fuel.

The experiments carried out by us were made purely in the interests of our readers, and in response to the invitation so freely offered by the Syndicate to any persons who cared to investigate a matter so important to the engineering community. While it is possible that further tests, more elaborately carried out and extending over a longer time, may show that our figures require corrections, yet we feel sure that such corrected results will only show the existence of small percentages of error either way. We think that, under the present circumstances, the wisest course which the Marchant Engine Syndicate can pursue will be to have the engine thoroughly tested at the Bow works of Messrs. Fraser and Fraser by a body of gentlemen whose tests, added to those already taken, will place the matter beyond dispute. Several well-known names readily suggest themselves to our mind, and adopting a method of reasoning analogous to that of the *Machinery Market*, we (until different results have been obtained by any reliable method) must retain our conviction that the Marchant engine is worthy of the solid attention of our readers.

EARLY TELEPHONIC APPARATUS.*

By Prof. A. E. DOLBEAR.

IT is recorded that Minerva sprang full armed from the brain of Jupiter. In very ancient times it was not a matter of wonderment that any event should happen without a natural history. In later times, however, there has been growing a conviction that events of all kinds have some ancestry, and if this is not so readily traceable in some cases, it has been believed that the obscurity is due to the difficulty of the search rather than the absence of genetic relations. If one may trust some sources of information to-day, our faith in the absoluteness of genetic ancestry must give way. The speaking telephone is the Minerva of to-day, and Prof. Bell is the Jupiter. The courts have solemnly declared that it has no ancestry, and those who sit at the receipt of customs are satisfied with the judgment. A hard-headed evolutionist might deny such a conclusion on general principles; and without either knowing or caring a button about the evidence or the lack of it, would declare the conclusion to be absurd.

It was reasonable to believe that the horse had geological precedents before Prof. Marsh had gathered the geneological series. Even then interested parties denied the conclusions and found two or three able men to help in the quarrel against nine-tenths of those competent to judge. There is no cure but death for such *lusus naturæ*, when they become interesting specimens upon the shelves of the psychologists.

If one, however, makes the inquiry as to what telephonic work was done before 1876 it is likely he will be surprised at both the work and the literature. I think it to be quite certain that but a handful of persons in this country had even heard of such a thing or had seen any of the publications containing descriptions of what had been made. As for myself, I never heard of such a thing until 1876. The journals containing the accounts were of small circulation and chiefly German and French.

On May 10th, 1876, Prof. Bell presented a paper to the American Academy of Arts and Sciences at Boston on "Researches in Telephony," in which he exhibits his industry in searching out what others had done, for he refers to upwards of 60 papers on the subject by others, aside from his own work.

It will be interesting to look over the literature existing before 1876 to see what one could have learned about telephonic apparatus, its structure, modes of operation, as well as the principles involved. Thus one will be able to compare the telephone of to-day with its antecedents.

In *Didaskalia*, September 28th, 1854, is a description of an apparatus for the "Electrical Transmission of Speech," by Charles Bourseul. The following is the part descriptive of the mechanism:—

"Suppose that a man speaks near a movable disc, sufficiently flexible to lose none of the vibrations of the voice, that this disc alternately makes and breaks the current from a battery, you may have at a distance another disc which will simultaneously execute the same vibrations.

"An electric current traversing a metallic wire changes a piece of soft iron in the vicinity of which it passes into a magnet. As soon as the current ceases, the magnetic quality ceases. This magnet, the electromagnet, can thus alternately attract or let go a metallic plate.

"It would be possible to so arrange this second metallic plate so that it repeated simultaneously exactly the same vibrations as the first plate, and it would then be exactly the same as if one had spoken in the immediate vicinity against this second plate, or the ear would be affected precisely as if it had received the tones directly through the first metallic wall."

A diagram (fig. 1) will show at a glance the apparatus here described. I do not know whether young Bourseul ever constructed his apparatus or not, but he speaks with conviction as to its possibilities.

Du Moncel published this same account about the same time, calling it a "fantastic conception," and apologised for giving it room in his book.

Phillip Reis, of Germany, to whom we are indebted for most that was done, began his work in 1860 and 1861. I have met with no evidence that he knew of Bourseul's proposals, and I have the opinion that he had not heard of them, but began the subject anew. His transmitters, of which he made several varieties, embraced the same features. The following is Reis's description of one, as given in a lecture delivered in Frankfort-on-the-Main, and published in 1861, in the *Journal of the Physical Society*:—

"In a cube of wood (fig. 2) there is a conical hole, *a*, closed at one end by a membrane, *b*, upon the middle of which a little strip of platinum is cemented, as a conductor of the current. This is connected to the binding screw, *p*. From the binding screw, *n*, there passes likewise a thin strip of metal over the membrane, and terminated here in a platinum wire, which stands at right angles to the length and breadth of the strip."

In 1863 there was published in *Böttger's Polytechnisches Notizblatt*, in *Dingler's Polytechnisches Journal*, and in *Polytechnisches Centralblatt*, the following description of Reis's transmitter: "A little light box, a sort of hollow cube of wood, has a large opening at its front side and a small one at the back on the opposite side. The latter is closed with a thin membrane, which is strained stiff. A narrow springy piece of platinum foil, fixed at its outer part to the wood, touches the membrane at its middle. A second platinum strip is fastened by one of its ends to the wood at another place and bears at its other end a firm horizontal spike which touches the other little platinum strip where it lies upon the membrane."

In a description of Reis's apparatus, published in Vienna in 1865, and now known as Pisco's, aside from the foregoing, there is the additional statement, "It is plain that the platinum strip may be replaced by a thin strip of brass and the platinum or steel points by

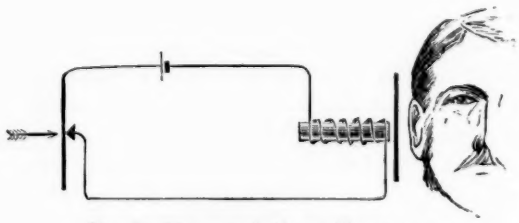


FIG. 1.—BOURSEUL'S IDEAL TELEPHONE.

iron ones," showing that the experimenters did not confine themselves to platinum terminals.

In many places a kind of transmitter is figured, consisting of a hollow tube with the vibrating parts affixed to the top in such a way that gravity keeps them in contact when they are at rest, instead of the spring needed and provided in the bored-block pattern.

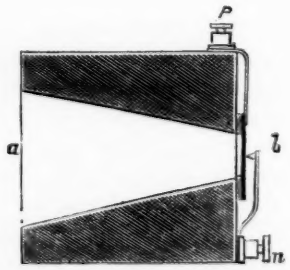


FIG. 2.—REIS'S TRANSMITTER.

In a transmitter made among the first, and modelled after the human ear, there was provided an adjusting

* Read at the Buffalo meeting of the American Association for the Advancement of Science, August, 1886.

screw to maintain proper tension between the terminals. A transmitter made by Reis and given by him to Professor Böttger has such a screw.

The Reis publications describe and figure two receivers, both operating by electro-magnetism, one utilising what is called the Page effect, the other the inductive action of an electro-magnet upon an armature. The latter is thus described by Legat in the *Journal of the German-Austrian Association* in 1862. "The electro-magnet of the apparatus, in accordance with

FIG. 3.—IRON CORE WITH PERMANENT MAGNET.

the condensations and rarefactions of the column of air (in the transmitter), is correspondingly demagnetised and magnetised, and the armature of the magnet is set into vibrations like those of the membrane in the transmitting apparatus."

This description of the apparatus was published in a number of foreign journals, some making the account briefer and some expanding it and adding to it the work of other experimenters. Thus, in *Cosmos*, Vol. XXIV., 1864, I find the following: We already

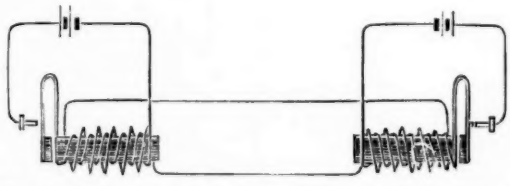


FIG. 4.—INDUCTION COIL AS RECEIVER AND TRANSMITTER.

know certainly that the intensity of the sound increases as a softer iron is used, because, in that case, the molecules have more freedom of motion than they had in the hardened iron or steel. If the iron core (fig. 3) is magnetised by the influence of a permanent magnet or by another coil, its sound is more intense when the intermittent current is sent in such a direction as to produce a demagnetising effect upon it, and it is less intense when the current is sent through the helix in such a direction as to increase the magnetism.

In a book published in 1872, called "The Wonders of Electricity," there is a description of the telephone by one named Baile. The receiver is thus described: "At the extremity of the line the current enters an electro-magnet which attracts a vibrating plate of size and quality identical with that in the transmitter."

A still more striking and important publication was contained in a foot-note to an article on "Disorders of the Spinal Marrow and their Treatment by Electricity," by Dr. Clemens in the *Deutsche Klinik*, No. 48, 1863, and is as follows:

"This most wonderful phenomenon of the transmission of sound in the electrified wire I have observed once before about ten years ago in the following manner. A strong induction coil was operated by one cell of battery and the current conducted above ground through a copper wire several hundred feet long from my study to a distant garden house. As soon as the wire thus extended was attached at the further place to a strong coil, one could hear in the farther coil quite distinctly the running of the machine and likewise perceive at the second coil any sound which was able in any way to set up strong vibrations. Shouting into a funnel, blows upon a metallic plate, &c., if directed toward the induction coil, were heard distinctly in the farther coil like the tones of an Eolian harp."

As the contributor was a physician, it was most probably an induction coil made for medical purposes, and such coils were then made with an automatic make-and-break operated by a magnet attracting an armature.

The primary circuit was through platinum contacts, one of which was fixed upon a flexible spring, while the other was an adjustable screw. It could operate, therefore, like the Bourseul and Reis transmitter contacts precisely, and could readily respond to forced vibrations.

The secondary coil, of course, had its proper function, as usual, and set up still greater difference of potential.

I was interested to try such a coil as a transmitter, and borrowed one that was thirty years old for the purpose. With an ordinary magneto receiver there was no difficulty in hearing many words with the receiver a foot or more distant from the ear. But this transmitter, fig. 4, is interesting still further on account of the presence of the magnet and its armature capable of responding to forced vibrations; for such motions of the armature react upon the magnet, setting up magneto-electric waves in the coil, and thus conspire with the varying current in the primary to increase the effect. It is the magneto-electric transmitter combined with the variable resistance transmitter, and, furthermore, where two such instruments are coupled in one circuit, each provided with its battery, the primary circuit in the receiving instrument assumes the function of what has since been called the thermal telephone, and is in substance the same as Berliner's telephone of 1877.

If one recalls all that makes up the magneto-speaking telephone to-day, in the transmitter, the vibrating plate of iron, the delicately movable electrodes, the battery of two or three cells, the secondary coil; and in the receiver, the electro-magnet of soft iron as a pole piece for a permanent magnet, the disc of iron about the same size as that in the transmitter, and still further thinks of the succession of changes, mechanical, electrical, magnetic and acoustical, which take place when being operated, and compare with these the corresponding ones described in these old journals, it will at once be obvious that there has not been a single new feature in the mechanism, or new principle in the mode of operation, added since 1875; and, however much the present telephones may perform better than the early ones, it is only a matter of degree. It will also be apparent that one who was acquainted with the literature on the telephone previous to 1876, was fairly well equipped for making telephones, and lastly he will be persuaded that the telephone of 1876 had a pedigree and was not a new creation.

AN ELECTRIC LOG.

MR. SAM HUBBARD, writing in *Science*, says:—In May, 1882, I sailed from Marseilles for the Piræus on the steamship *Ava*; Capt. Hug. Bretel, of the Compagnie des Messageries Maritimes, commanding. A short time after going aboard I noticed a small rope running through the saloon over the cabin doors to the after skylight, and thence along the side of the ship to the stern, where it was made fast. The next day I saw the captain and the first officer looking at a curious instrument, which looked something like an aerometer, except that the cups revolved in a vertical position. This instrument was fastened to the rope which I have mentioned, and thrown overboard, the captain meanwhile watching the revolutions of the wheel through a powerful field glass. As it did not seem to work satisfactorily, it was hauled in; and I noticed that the captain, in making some repairs to the rope, used a stick of Chatterton's compound. This led me to believe that there was a copper conductor in it, and that electricity in some form was being employed. There was no opportunity at that time to make inquiries; but a few days later the captain kindly permitted me to see the instrument, which he called a "loch-moulinet," or "electrical-mill-log." After

throwing it again into the water, he took me forward and showed me the earth connection, which was soldered fast to one of the iron beams of the ship. Thence the wire went through the chart-room to the wheel-house, where there was a telephone. This electric log, it seems, was the joint invention of Capts. G. Fleuriais and Bretel, and was so arranged, that, when connected with the cable, it formed part of an electric circuit, which was opened and closed with every revolution of the copper shaft to which the four cups or hemispheres were attached. The number of revolutions made by the shaft in a given time was of course dependent upon the speed with which the cups were dragged through the water; in other words, regulated by the rate of motion at which the ship was moving. A table had been prepared by the inventors, showing the number of knots per hour corresponding to the number of revolutions of the shaft in a half-minute. On placing the log and telephone, so arranged that it could be switched, in circuit, every revolution of the shaft, and consequent closing of the circuit, caused a click, plainly audible to anyone listening at the telephone. The log having been allowed to run out to such a distance as to be practically free from the influence of the screw, I listened at the telephone. The sound, like a tapping on the diaphragm of the telephone, came clear and distinct; and, when the captain turned the half-minute glass, I had no difficulty in counting the revolutions of the shaft, seventy-four in number. On referring to the table, it appeared that we were making eight and five-tenths knots, which was the exact speed of the ship as shown also by the revolutions of the engine. The experiment was very satisfactory and extremely interesting. Captain Bretel wrote out a description of his invention, with drawings, which he gave to me.

In the accompanying diagram, A, B, C, D, are four hemispherical cups on the ends of four arms affixed to a brass shaft, E, F, which revolves freely in lignum-vitæ bearings at the extremities of the jaw, H, K, L. For convenience in removing the shaft, the bearing at H is detachable, being secured in place by the wing-nut, I. At one end of the shaft is a small lignum-vitæ pulley, P, Q, having on one side a strip of copper, *mm'*, fastened in position by screws passing through the shaft, which screws make electrical connection between the copper strip and the shaft. An elastic tongue, O, on the screw, N, bears upon the other end of the shaft,

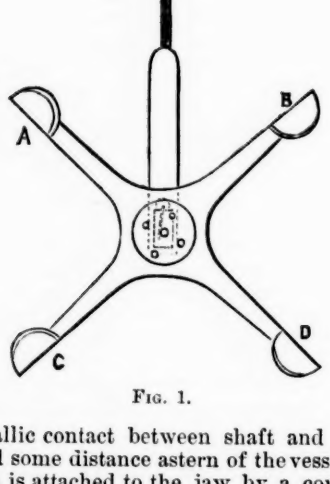


FIG. 1.

giving metallic contact between shaft and jaw. The log is towed some distance astern of the vessel by a log-rope, which is attached to the jaw by a copper shank and a clamping-screw, T. To this copper shank is secured a strip of zinc, thus forming a weak galvanic battery.

An insulated wire, U, furnishes electrical connection between the commutator brush or tongue, R, S, and a Bell telephone in the chart-room of the ship, the wire making several spiral turns around the log-rope to guard against snarling. With the log thus towing astern of the vessel, it is evident that at every revolution of the log wheel, A, B, C, D, an electric circuit between the telephone and the zinc and copper of the

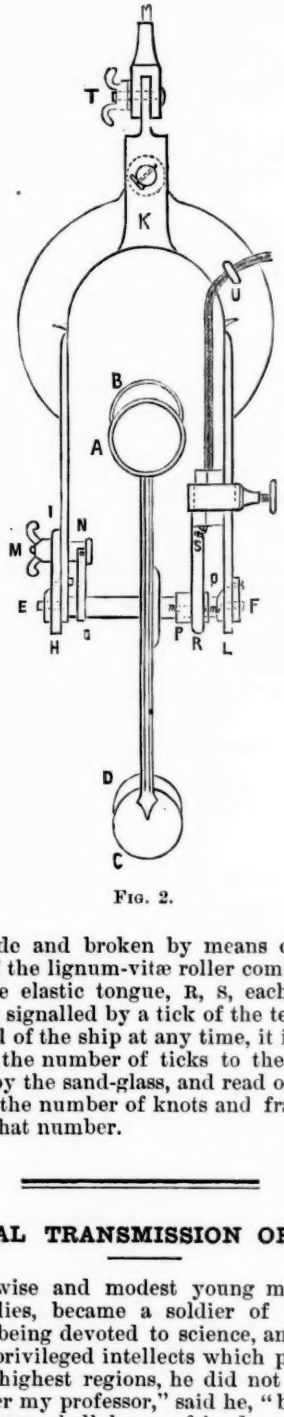


FIG. 2.

shank is made and broken by means of the copper strip, *mm'*, of the lignum-vitæ roller coming into contact with the elastic tongue, R, S, each "make and break" being signalled by a tick of the telephone. To find the speed of the ship at any time, it is only necessary to count the number of ticks to the half-minute, as measured by the sand-glass, and read off from a converting table the number of knots and fractions corresponding to that number.

ELECTRICAL TRANSMISSION OF SPEECH.*

IN 1845, a wise and modest young man, reared in peaceful studies, became a soldier of the army of Africa; but, being devoted to science, and gifted with one of those privileged intellects which permitted him to reach its highest regions, he did not despair. "I have no longer my professor," said he, "but I have yet my books; these shall be my friends, my guides, my consolers."

In 1849, at length, the young Charles Bourseul, son of an army officer and himself a soldier in the 43rd Line, gave his comrades of the garrison of Algiers a course of mathematics which attracted the attention and friendly interest of the Governor-General of Algiers. No one had recommended the simple soldier to the

* See our correspondence columns.

general; he had recommended himself, and the general, recognising his merit, had generously held out a protecting and friendly hand. There is in that simple fact a touching eulogy of the soldier and the general.

To-day, freed from military service, Mr. Charles Bourseul dwells in Paris, and it is he who is the author of the curious article which you are about to read. We wish him all the success that he himself expects, and we shall be happy to see him attach his name to the marvellous discovery of the transmission of speech by electricity. Electricity has performed so many miracles—why not that (in despite of the Academy, where it is treated as a folly, or, when one wishes to be polite, as utopian,) which has not yet been attempted?—a view which is encouraging, it is necessary to avow, for the inventors, for those sublime initiators without whom the Academy would be but a collection of fossils. Let us say it once more, to sustain the ardour of genius in the reach for the unknown,—there is nothing to expect, unless an insolent sneer, from these votaries of science. Fulton and enough of others learned so to their cost, but if you speak to-day to an Academician of steam and the telegraph, he will tell you the thing was very simple, and that if the Academy had wished to take the trouble, the discovery would have been made very much sooner. Ah, well, most wise doctors, here is a problem! Read the note of Mr. Charles Bourseul.

It is known that the principle on which telegraphy is founded is the following:

An electric current passing over a wire, comes to a piece of soft iron which it converts into a magnet. Whenever the current is absent the magnet has ceased to exist.

That magnet, which takes the name of electro-magnet, can, then, attract and set free in turn a movable plate, which by its coming and going produces the signals employed in telegraphy.

Sometimes one uses that movement directly, and makes it produce points and dashes on a band which is unrolled by a clock-movement. The customary signals are then formed by combinations of these dashes and points. Such is American telegraphy, which bears the name of Morse, its inventor.

One also converts that coming and going movement into a rotary movement. Thus are derived the dial-telegraph of the railroads and the State telegraph, which latter, by means of two wires and two needle indicators, reproduces all the signals of ærial telegraphy, as heretofore used.

Let us imagine now, placed on a horizontal movable circle, the letters, figures, punctuation marks, &c. One can see that the principle explained will serve to enable him to choose at a distance such and such a character, to determine its movement, and consequently to print it on a page placed for the purpose. Such is the printing telegraph.

A further step has been made. By means of the same principle and by a mechanism sufficiently complex, we have attained a result which, at first glance, seems a prodigy; writing itself is reproduced at a distance; and not only writing, but a stroke, a curve; in such manner that being in Paris you are able to design a profile by ordinary means and the same profile is designed at the same time at Frankfort.

The efforts made in these directions have succeeded; the apparatus has figured in the London Expositions. There is, however, something lacking to perfect the details.

It will seem impossible to go further in the direction of the marvellous. Let us try, however, to take some further steps. I have asked myself, for example, if speech itself cannot be transmitted by electricity; in a word, if one can speak at Vienna and make himself heard at Paris.

The thing is practicable; and this is how it can be done.

Sounds, everyone knows, are formed by vibrations, and carried to the ear by the same vibrations reproduced by the medium which intervenes.

But the intensity of these vibrations diminishes very rapidly with distance, in such a way that there are, even to speaking trumpets, horns, and acoustic cornets, very narrow limits which cannot be passed. I imagine that one is speaking near a movable plate, so flexible that it will not miss any of the vibrations produced by the voice; that this plate establishes, or interrupts successively, communication with an electric pile, you will be able to have at a distance another plate which will make at the same time exactly the same vibrations.

It is true that the intensity of the sounds will be variable at the point of departure where the plate vibrates from the voice, and constant at the point of arrival, where it vibrates from the electricity, but it is shown that it cannot alter the sound.

It is evident, also, that the sounds will be reproduced at the same height of the gamut.

The present state of acoustic science does not permit one to say, *a priori*, whether the articulate syllables of the human voice can be reproduced. The manner of producing these syllables has not been sufficiently studied. It has been remarked, it is true, that some are pronounced from the teeth, others from the lips; but that is all.

However that may be, it is necessary to suppose that the syllables are exactly reproduced (to the ear) by nothing but the vibrations of the intervening medium; reproduce, then, those vibrations, and you will also reproduce exactly the syllables.

In any case, it is impossible to demonstrate in the present state of science the impossibility of transmitting sound by electricity. All the probabilities, on the contrary, point the other way.

When it was first proposed to transmit dispatches by electricity, a man in the high ranks of science treated the idea as extravagantly utopian, and yet we communicate directly between London and Vienna by a simple wire. That is not possible, they say, and it is done.

It goes without saying that applications without number, and of the highest importance, will arise immediately from this principle of transmitting speech by electricity.

Not to be deaf and dumb, whoever is that can use this means of transmission, which will need no apparatus, an electric pile, two vibrating plates, and a wire will suffice.

In a multitude of cases, in vast industrial establishments, for example, one will be able by this means to transmit at a distance such an order or piece of information, whereas one will not do so by electricity so long as an apparatus such as is used in telegraphy and special training would be required to accomplish the object better by letter.

However it may be, it is certain that in a future more or less far off, speech will be transmitted for long distances by electricity. I have begun experiments; they are delicate and require time and patience; but as far as I have gone the results promise a favourable issue.

CHARLES BOURSEUL.

Paris, *August 18th*, 1854.

A NEW EXPERIMENT IN STATIC ELECTRICITY.

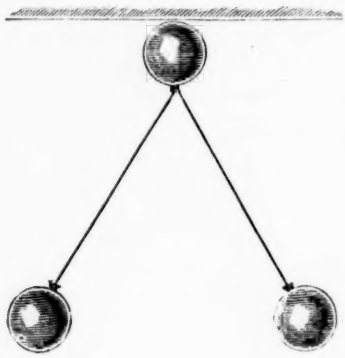
IN devising some electrical experiments suitable for exhibition to a small audience, writes H. A. Doty in the *Scientific American*, I sought for a simple and novel way of showing the fundamental phenomena of electrical attraction and repulsion; and reflecting on the strong electrical properties of rubber, it occurred to me to test the possibilities of the common toy rubber balloons, as they seemed to offer the advantages of large exciting surface and small weight, both of which are important desiderata in experiments of this kind. A trial proved them particularly adapted to striking and interesting demonstration. My first experiments

were made with the ordinary grade of toy balloons, which have a red-stained wooden mouthpiece containing a "squawker," well known to small boys and adults who have been harassed by their intermittent squawking. These common balloons may be procured at almost any toy store for a few cents each.

They are inflated with the breath and tied at the end with silk or thread, when they may be pushed off the tube. If one of these inflated balloons be thoroughly stroked with a cat skin, it becomes strongly electrical, and will fly to the body or adhere to the hand if held over it, or it may be rapped up to the ceiling with a small stick.

Its adherence to the ceiling is remarkably persistent. I have repeatedly had balloons remain in such positions for more than four consecutive hours. Numerous instructive experiments may be made with them singly or in combination, and the few here described will suggest others. Their strong attractive force implies, of course, strong repellent force. If two are suspended by threads of the same length, and excited with the cat skin, they will be pushed apart two or more feet, the distance depending to a great extent on the length of the suspending threads. If the hand be now brought between them, they will be attracted to it, and if it be suddenly withdrawn before the balloons have touched it, they will bound away from each other almost as if they had struck a wall.

A very pretty experiment is illustrated by the engraving. Two of the balloons are hung with equal



threads to a third, the threads being of such length that when the third balloon is against the ceiling the others may be conveniently reached. The third balloon is now excited, and put against the ceiling by means of a long stick. If properly done, the attraction is amply sufficient to support the two other balloons. These latter are now excited, care being taken not to pull the supporting one away from the ceiling; and as their mutual repulsion forces them apart and they float airily around each other, the whole group affords a demonstration of both the attractive and repellent forces of electricity so striking that it can hardly be appreciated until it is seen. If a strip of hard rubber be electrified with the cat skin and put between the suspended balloons, they fly still further apart, and one of them may be chased around, or made to rise vertically by a little dexterity with the rubber strip. By arranging say haf-a-dozen balloons in the form of a hexagon horizontally on threads strung across a room or on a suitable light frame, it is quite possible that another balloon could be suspended in mid-air by the combined repulsion of the group when in a good state of electrical excitement. This would be a very effective experiment, although it has not yet been tried.

There is a choice among the balloons of different grades for these experiments. The cheaper kind I have found almost unexceptionally satisfactory, but it seems impossibe to electrify the better ones, which are heavier and more highly coloured. Probably the colouring matter gives them more or less conductivity, so that the charge excited on them easily flows off. It may be, however, that by thoroughly extracting the colouring matter with alcohol or otherwise, they may be made available for electrical purposes, in which case their larger size might make them specially desirable in some experiments. It should be added that, like most experiments with statical electricity, these succeed only in cold weather.

REGULATION OF DYNAMOS BY THE MOVEMENT OF THE COMMUTATOR.

ONE of the earliest and best known methods employed in the regulation of dynamos so that they shall generate the proper strength of current, says the *Electrical World*, is that effected by shifting the brushes around the commutator. It is evident, however, that the same result could be obtained by maintaining the brushes in

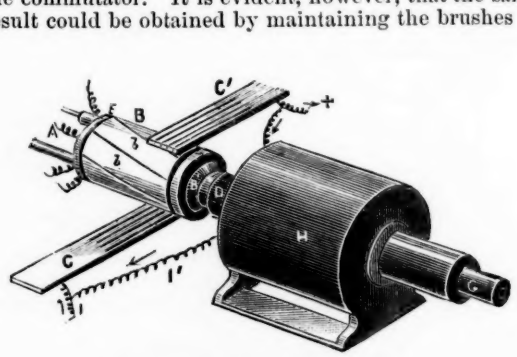


FIG. 1.—MOVABLE COMMUTATOR.

a fixed position and changing the relative position of the commutator.

Such a method has recently been devised by Mr. R. M. Hunter, of Philadelphia, and the manner in which it is put in practical operation is shown in the accompanying illustrations, figs. 1 and 2, which represent respectively exterior and sectional views of the regulator.

As will be seen, the armature shaft, A, is provided with a feather or key, A′, which fits in a slot in the commutator, B. The sections of the latter, *b*, are shaped in the form of helices. It is evident, therefore, that if the commutator be moved longitudinally on the shaft, being prevented from rotation by the key, that the brushes will advance a section. The amount of this advance is dependent upon the pitch of the helical sections, which can be made variable.

The commutator has a brass head, B, which is secured to the soft iron core, D; the latter enters the solenoid,

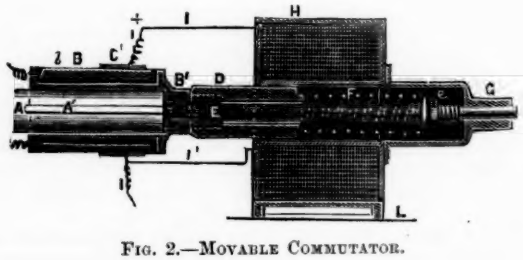


FIG. 2.—MOVABLE COMMUTATOR.

H, and is guided by the spindle, E, which is secured to the armature shaft, and has a steady bearing at G.

The function of the spring, F, is to oppose the attractive force of the solenoid. The latter is placed in the shunt circuit, I′; hence, as the resistance in the line increases the current passing through the solenoid increases in a proportional ratio. The core is therefore drawn in further and moves with it the commutator,

thus changing the relative position of the segments under the brushes.

It is evident that the same thing can be accomplished by allowing the commutator to remain fixed on the shaft, and moving the brushes not circumferentially, as usual, but in a line parallel with the length of the commutator.

NEW LECTURE EXPERIMENTS ON TRANSFORMERS OF ELECTRIC ENERGY.

HITHERTO Ruhmkorff's coil has most frequently been used in lectures, says *L'Electricien*, merely to produce currents of high tension, or, as it is very improperly said, to convert dynamic electricity into static electricity.

This heresy has had its day, and we now consider Ruhmkorff's coil merely as a special form of transformer by induction, modifying at will the two principal factors of a periodic current intensity and electromotive force according to the nature and the relations of the inducing and induced circuits.

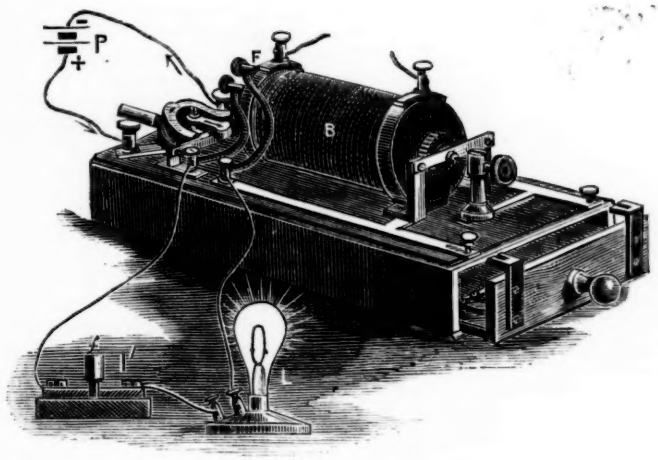


FIG. 1.

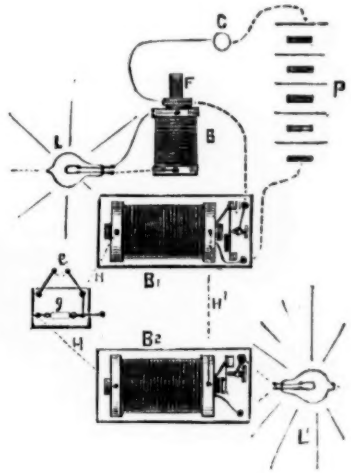


FIG. 2.

The experiments of transformation, for which the coil is adapted—and in particular the portable demonstration model of Ducretet—are numerous and varied. We will particularise some which are especially brilliant and conclusive, and are easily adapted for lecture experiments in which the effects are shown by incandescence lamps, constituting galvanoscopes highly sensitive and visible to a numerous auditory.

The transformation may be effected either by utilising self-induction or the extra current, or by means of the phenomena of mutual induction.

Self-Induction.—Fig. 1 shows the disposition of the experiment. A battery, P, the electromotive force of which is insufficient to supply directly an incandescence lamp, L, but is able to give under the conditions of maximum power a number of watts greater than that which the lamp requires to act normally, is connected to the inducer of a Ruhmkorff coil. The lamp is placed in derivation at the extremities of the inducer. When the coil is set in action the lamp becomes incandescent, because at the moment when the circuit is opened by the oscillator, the extra current (the electromotive force of which is very high) is sufficiently intense to produce this illumination. The interposition of the lamp diminishes the breaking spark at the oscillator, which becomes stronger if the lamp is suppressed. The effect of the condenser is also shown by the lamp, which becomes less brilliant if the condenser is withdrawn.

Mutual Induction.—We utilise two ordinary Ruhmkorff coils, B_1 and B_2, and the classic apparatus, B, employed in lectures to demonstrate the general laws of induction.

First Experiment.—We arrange in circuit the battery, P, the inducing circuit of the coil, B_1, and the inducing circuit of the apparatus for demonstration. The coil, B_1, serves to produce an interrupted current in B. The lamp, L, connected to the induced currents of B, is illuminated immediately. We may diminish the lustre of the lamp by withdrawing more or less the iron core, F, which decreases the co-efficient of mutual induction of the two circuits of the apparatus.

Second Experiment.—The coil, B_1, being arranged as in the first experiment, we connect the ends of the induced wire of B_1 to the ends of the fine wire of B_2, which thus becomes an inducing circuit, introducing into this circuit an experimental table. We adjust the oscillator of B_2, and we connect a lamp, L', to the two ends of the thick wire of B_2. Under these conditions, the lamp, L' burns with a lustre, which can be regulated at will by acting upon the length of the spark which plays between two points arranged at *e* upon the experimental table, or by introducing a Geissler tube upon this table. The simultaneous illumination of the tube and of the incandescence lamp shows at once the two inverse transformations of the current furnished by the battery, P. The maximum lustre of L' is obtained by making the space, *e*, null, and withdrawing the iron core, F, from the apparatus, B; in this case L becomes dim.

The inverse effect is produced by replacing F and withdrawing the movable core of B_2.

To succeed, we require six accumulators or six bichromate elements, and lamps of about 20 volts. Numerous variations may be introduced into these experiments which show so strikingly the reciprocal effects of self-induction and the mutual induction of circuits traversed by periodic currents.

ELECTRIC LIGHTING AT LIVERPOOL EXHIBITION.

THE whole of the electric lighting of the above exhibition including the supply of the requisite steam power, was entrusted by the Executive Council to the Liverpool Electric Supply Company, Limited, and the work has been carried out in accordance with the plans prepared by Messrs. Holmes and Vaudrey, the managing engineers of the company. The main building is lighted by 280 arc lamps and more than 1,000 incandescent lamps, the latter being supplied to exhibitors at a small rental charge. Many of the incandescent lamp

fittings, supplied to the various exhibitors by the Liverpool Electric Supply Company, are of very artistic design, greatly adding to the attractive appearance of the exhibition in an evening.

The arc lamps are manufactured by the Anglo-American Brush Company. The dynamos for running them comprise two 50-light machines, with the new laminated wrought iron armature and driven each by a 20 horse-power engine and six 35-light machines driven by three 30 horse-power engines, two dynamos to each engine. In the interior of the buildings there are 240 arc lamps divided into six circuits, so arranged that each portion of the building is lighted by at least two circuits, so that no portion would be left in darkness by the temporary stoppage of any one dynamo or engine. In addition to the above lamps which are arranged in series, there are also in the building 40 arc lamps, arranged to run in multiple series from the incandescent lamp circuits. This plan of running arc and incandescent lamps on the same mains was introduced into Liverpool by Messrs. Holmes and Vaudrey more than two years ago in the Central Station Works of the Liverpool Electric Supply Company, and has been in successful nightly operation ever since. The grounds are lighted by 70 arc lamps, arranged on poles 40 feet high, two lamps on each pole, and forming part of two separate circuits. The incandescent plant consists of one 700-light, and four 600-light Victoria Brush dynamos, and four Crompton dynamos, capable of supplying respectively, 300, 200, 100, and 50 incandescent lamps. Of the latter machines the largest size is driven by rope gear, and is exactly similar to four other machines recently supplied by the Liverpool Electric Supply Company to the White Star Line for the steamers *Britannic* and *Celtic*. The smallest Crompton machine is provided to supply the powerful arc lamp which surmounts the full sized model of the Eddystone Lighthouse in the gardens. The four Victoria dynamos are driven by two pairs of 40 horse-power compound engines, the smaller machines being driven each by the vertical engines.

The main front of the building has been lined out with incandescent lamps, arranged in a geometrical pattern, and presents a very effective appearance. Incandescent lamps are also used in the state rooms fitted up for Her Majesty the Queen, and in the reception rooms of the Liverpool Corporation. The refreshment rooms and exhibition offices are lighted in the same way, bringing up the total number of incandescent lamps to about 2,000.

Each portion of the building lighted by incandescent lamps is supplied by at least two circuits and dynamos; the three-wire system of mains being used in some cases, this being the first time that this system has been used on a large scale in this country. The electric lighting machinery is arranged in a very compact and convenient manner in a special court measuring about 90 feet by 80 feet, and no expense has been spared by the contractors to render the installation as perfect and efficient as possible. The Liverpool Electric Supply Company also exhibit, in conjunction with Messrs. Crossley Brothers, of Manchester, a number of gas engines and dynamos, specially suitable for the electric lighting of private houses. The 5-man-power gas engine, fitted with small Crompton dynamo driven by a friction pulley from the engine flywheel, is an example of the simple way in which a small house may be lighted by electricity at a very moderate cost and without any complicated apparatus. The ½-horse, 1½-horse, and 4-horse sets of plant, with corresponding dynamos, are suitable for houses of larger requirements, especially when used in combination with accumulators, an assortment of which, manufactured by the Electrical Power Storage Company, is also exhibited.

The steam power consists of twelve engines made by Messrs. Marshall, Son & Co., Brittania Works, Gainsborough, of the following types:—Three 30 horse-power compound, and three 20 horse-power compound stationary engines, with the working parts beneath the boilers. Two 40 horse-power compound separate stationary engines. One 14 horse-power vertical engine with grooved flywheel for ropes. One 10 horse-power vertical engine. One 8 horse-power vertical engine, and one 4 horse-power vertical engine. The latter six engines are supplied with steam from three 40 horse-power locomotive multitubular boilers, placed side by side, working at 140 lbs. pressure.

Oldfield and Walton's link belting is used for all the dynamos except the one driven by rope gear, and all machines are driven direct from the flywheels of the engines, without the intervention of countershafts.

All the main cables and smaller wires have been supplied by Messrs. W. T. Glover & Co., of Salford.

TRANSATLANTIC CABLES.

THE *Matin* of Paris refers at some length to the struggle for supremacy now going on in Paris between the directors and a large section of the shareholders of the Pouyer Quertier Company. We make the following extracts from this journal, which will be all the more interesting as the boards of the English Transatlantic Companies have sent over to Paris an influential deputation composed of their most prominent members. The *Matin* refers to the negotiations carried on in former years through a Mr. Harding. We are not aware that this gentleman is connected with the present mission, but there is little doubt that either he or some one of equal reputation will be easily imported into the business should a favourable opportunity present itself.

The *Matin* says: "The auditors have presented their report on the accounts for 1885, and the directors remark that it is with a legitimate satisfaction that they publish this report. It appears from the report, however, that the auditors have done everything in their power to avoid being unpleasant to Messrs. Pouyer Quertier and Riant. We are convinced that if these auditors had been directors of the company they would never have run the risk of presenting such absurd statements of accounts to the shareholders. The accounts are like the other statements made in the report of the directors void of any solid foundation." The same journal then gives a not very flattering history of some of the men now composing the board of this unhappy company. The *Matin*, after pointing out how undesirable a thing it is to leave the affairs of the company in the hands of such men, adds that should the directors defeat the shareholders the writer sympathises with, at the meeting of the 6th October, there is little doubt that at the meeting in May next these shareholders, who will be represented by 40,000 shares at least, will gain the day. The battle is one of the greatest interest to the Anglo-American, to the Direct United States Company, and to the American Cable Company, as should the Mackay-Bennett interest capture the Pouyer Quertier Company, the pool agreement existing between them and this company will be always a dangerous thorn in their side.

Opposed Patent.—In the abstract given in our last issue of patent No. 11,652, dated September 30th, 1885, for "Improvements in the manufacture of plates or elements for voltaic batteries," the name of Mr. W. H. Tasker should have been associated with that of Mr. T. J. Jones as one of the patentees. We are informed that notice of opposition to the granting of this patent, on the ground that the alleged invention was obtained from him, has been filed by Mr. Desmond G. Fitz-Gerald, whose patent for "Improvements in the manufacture of elements for voltaic batteries," embracing the invention of "lithanode," is dated April 15th, 1885, No. 4,671. An abstract of this patent appeared in our issue of May 28th last. We can make no comment on this matter whilst it is still *sub judice*, but our readers will be able to compare the two specifications in question.

THE BRITISH ASSOCIATION.

(Specially Reported for the "Electrical Review.")

ELECTRIC ILLUMINATION OF LIGHTHOUSES.

By DR. J. HOPKINSON.

(Section G.—Mechanical Science.)

Monday, September 6th.

THE employment of the electric arc as a source of light for lighthouses has received attention for many years, but no apology is needed for returning to the subject, as the rapid development of electric apparatus brought about by the use of the electric light for other purposes, and the perfecting of new forms of motive power continually introduce new aspects of the question. An elaborate experimental enquiry has recently been conducted by the Trinity House concerning the relative advantages of electricity, oil, and gas as lighthouse illuminants, the actual experiments being addressed mainly to a comparison of the results obtainable in a practical shape by each illuminant *in its maximum development*, and it was conclusively proved that whether in thick weather or in clear the most powerful light at a distance and the most penetrating in fog could be exhibited from the electric arc. A further inference was drawn from a consideration of estimates of cost of the three systems, viz., that the electric light was necessarily costly and could only be economical when enormous power was needed. The latter inference is no doubt valid so far as the particular electrical and mechanical appliances considered by the Trinity House Committee are concerned. The question may, however, be looked at from another point of view: given a limited permissible outlay and a limited annual charge for attendance and material, what can be done for the mariner by the aid of electricity?

Let us first see what are the intrinsic advantages of the electric arc. They all lie in great power in exceedingly small compass. The effect of the small size of the arc light upon the power of the light when used with optical apparatus has been often pointed out, and the accuracy with which positions of danger can be marked by coloured sectors is also familiar to engineers. Less consideration has been given to the fact that it is undesirable to make the brightness of the light at any distance unnecessarily great, as excessive brilliancy dazzles the eye. It is a desideratum then whilst directing as powerful a beam as possible to the distant sea to avoid throwing more than a moderate illumination on the nearer sea. It is possible to realise this desideratum far more effectually with a small source of light like the electric arc than with any other illuminant, but with the exception of one lighthouse so far as I know it has been very partially attempted, the reason being a fear that the proper position of the arc could not be maintained. Almost the only complaint made by the mariner of existing electric lighthouses is that at a moderate distance they are dazzling. This is solely due to the fact that too much light is directed to the sea, or which comes to the same thing for this purpose, the beam directed to the horizon has, in order to cover any possible error of position of the arc, too much divergence imparted to it. Owing to improvements in lamps and carbons it is now safe to concentrate the light much more closely upon the horizon with the double advantage of greater power where the light is wanted, and moderated power where excessive power is injurious. This view is fully confirmed by the experience of the two most powerful lighthouses yet erected, otherwise than by way of experiment. Macquarie, in New South Wales, and Tino, in Italy, both constructed by Messrs. Chance Brothers & Co. The former is a first order optical apparatus, focal distance 92 cms., and although the concentration on the horizon is greater than in any previous lighthouse, complaints have been made that the light is too bright at short range.

Tino is a second order, 70 cms. focus, and the principle of strictly limiting the divergence and giving a smaller proportion of the whole light to the nearer sea is carried much further. The result is that in clear weather the apparent brightness of the light as seen from the sea increases with the distance until a distance of 8 or 10 miles is attained when full power is reached. By means of the simple optical appliances provided, there has never been any difficulty in keeping the source of light accurately at the focus. Experience then shows that a specially advantageous distribution of light between the nearer and more distant sea may be obtained with the electric light, provided a large and suitable optical apparatus is used. Distinction of lights apart, the true measure of efficiency of a lighthouse may be said to be the fewness of the occasions at which it fails to be visible at its advertised distance, subject to the condition that at no distance shall its brightness be an annoyance. This is attained by greater optical concentration towards the horizon with limited illumination of the sea together with the power of widely varying the intensity of the sourse of light, conditions which can be better realised with the electric arc than with any other source. The electric light possessing the advantages named, it is its supposed great cost which bars its introduction in many lighthouses.

Why, then, should the electric light be so excessively costly in a lighthouse for any but the very greatest powers, such as are only worth providing for a few important landfalls?

The great cost both of first outlay and maintenance appears to arise almost entirely from the fact that the machinery is arranged to supply on each and every night, however clear, an unnecessary amount of power, and consequently the heavy machinery always used is remote from the lantern, and it is necessary that two men shall always be on duty, one in the lantern, another with the machinery. Further, the dynamo machinery selected has been of a costly and cumbrous description. The essentials for a cheap electric lighthouse are, that for ordinary states of the atmosphere there shall be provided a plant under the easy control of the lightkeeper himself, and which shall be precisely adapted to produce that amount of light which is wanted in ordinary states of the atmosphere; but for thick weather there shall be provided a much more powerful engine and dynamo, available also as a reserve, in case the smaller machinery from any cause breaks down. The occasional machinery may be more remote from the lantern, as it is a small matter to require a second man to work on the comparatively rare occasions when the maximum power is needed. A small gas engine and dynamo machine can be placed without any crowding in the room immediately below the lantern, and arrangements can be made whereby the lightkeeper, whether he is in the lantern or in the engine room, can ascertain at a glance whether the arc is in its proper position with an error of less than one millimetre. The attendance on the lamp, rotating apparatus of the lens (if a revolving light) engine and dynamo would be easy, when the whole is brought together so as to be under observation at once; in fact, the gas engine, dynamo and lamp constitute together a gas burner which, though consisting of many parts, is automatic throughout, and when at work requires nothing but the constant presence of a custodian, exactly as a gas lamp in a lighthouse requires a custodian as a guarantee against failure. The same end, viz., concentration of the whole mechanical and electrical apparatus under one pair of eyes, could be attained, of course, in other ways, accumulators could be used, or a petroleum engine, but in order to give definitions and afford facilities for criticism, the better course will be to describe a suitable machinery, state what it will do, what attendance it will require, and what it will cost.

I propose, then, for an electric lighthouse, where small outlay is essential, the following:—A Dowson gas-producing apparatus and gas holder, the generator and super-heater being in duplicate, each capable of making 1,200 feet of gas per hour, the gas holder having a capacity of 3,000 cubic feet.

An eight-horse nominal Otto gas engine and series-wound dynamo machine, placed in a room near the base of the tower and copper conductors to the lantern. The dynamo having magnet coils divided into sections so as to supply a small current when required.

A one-horse nominal Otto gas engine and dynamo machine, placed in the room immediately beneath the lantern floor, with gas pipe from the gas holder, one spare armature. Current and potential galvanometers and switches. Three electric lamps to receive either carbons of 25 mm. or any lesser size with complete adjustments for accurate focussing. The positive carbon below. One paraffin lamp as a stand-by. An optical apparatus of the second order, 70 cms. focal distance, extending from 29° below the horizon to 80° above. The cost of this apparatus would depend upon the character of the light it was intended to exhibit. To fix ideas, let it be assumed that the light is to be a half-minute revolving light showing all round the lighthouse. There could then be supplied a 16-sided apparatus, with pedestal and revolving machinery. Provision would be made in the optical apparatus for giving the horizontal and vertical divergence desired by the same methods successfully used in the lighthouses of Macquarie and Tino. Two focussing prisms would be fixed to form magnified images of the arc on pieces of obscured glass let into the pedestal floor, so that the keeper, whether in the lantern or in the engine room, can see at a glance the state of the arc, and observe whether it is of proper length with the carbons in line, whether it is exactly at the right height and in the centre of the apparatus. An error of 1 mm. would be glaringly apparent, and call for immediate adjustment, although its effect would be only a displacement of the beam five minutes of angle.

The lantern would be 10 feet diameter, with bent plate glass. The cost of the whole described would be materially less than £3,400, the cost of a first order light and lantern with oil lamps and large burners.

Let us now see what result would be obtained.

In fine weather, the small engine would be used. Its effective power on the brake is fully 1½ horse-power, from this 1½ horse-power the dynamo machine produces considerably over 800 watts, say 800 watts in the arc itself, or 20 ampères through a fairly long arc of 40 volts. Of course the value of this in candles depends upon the colour in which it is measured, and the direction in relation to the axis of the carbons. In red light the mean over the sphere would certainly exceed 1,200 candles. In clear weather, or in slight haze or rain, the beam of this light through the lenses would be much more powerful at the horizon and on the distant sea than any single focus light in oil or gas, or at least would be fairly comparable with anything yet exhibited with oil or gas, whether triform or quadriform. But on the nearer sea the illumination would be reduced, so that no annoyance would be caused by dazzling flashes. In really thick weather, or indeed any weather when there was a doubt as to the visibility at the horizon of the lower power, the large engine would be used under the superintendence of the second keeper. This engine will give 10 horse-power on the brake, and there is no difficulty in obtaining 85 per cent. of this as useful electrical energy outside the machine, that is 6,340 watts. From this deduct 10 per cent. for the leads and the lamps and for steadying the arc, leaving 5,710 watts in the arc itself, or 114 ampères, with

a difference of potential of 50 volts. Having regard to the fact that the optical apparatus here proposed acts upon a larger portion of the sphere than that used upon the South Foreland experiments, that the vertical divergence is less, and that the potential difference is greater, and the current continuous, although less in quantity, we may safely assume that the power of the resulting beam would not be inferior; indeed, the maximum number of watts actually developed in the arc in the lantern in the South Foreland experiments must have been materially less than $175 \times 40 = 7{,}000$ watts. It hence follows from the South Foreland experiments that in any fog whatever, the flashes would penetrate farther than those of any existing gas or oil light. The increased size of crater compared with that produced by the current of 20 ampères will give increased vertical divergence, and so cause the maximum illumination to be attained at a less distance from the lighthouse. The attendance of two men would suffice for all the duties of the lighthouse, because under ordinary circumstances one only need be on duty, excepting whilst gas is being made. The usual course would be, that with the exception of from two to three hours at the beginning of the night, the gas producer would be damped down, and when the small engine was at work the supply be taken from the gas holder. Consider the case of a long night of 15 hours. Immediately before lighting up the producer would be put to work and would require occasional attention from one keeper, but not his continual presence. For the first three hours of the night the engine would be using between 230 and 240 cubic feet of gas per hour, and the producer supplying between 1,200 and 1,300 feet, so that at the end of three hours there would be a store of 3,000 cubic feet, more than sufficient for the night, unless thick weather comes on, so that after three hours one keeper only would be on duty at a time, and he would always be in attendance on the light. In event of fog the keeper on duty would ring up his mate, who would start the larger engine and set the producer to work, and remain in attendance on engine and producer so long as the weather continued thick. A staff of two is adequate at all times, but it is true that more work would have to be done, both by day and night, about two hours, in gas making, and perhaps one hour in additional, cleaning of machinery. It would be a question of expediency depending on the amount of thick weather to be provided for, whether a third man should be engaged, or additional pay be given to two men, for the additional work demanded from them; adopting the latter course, the extra attendance would be covered by about £35 a year, with an extra allowance when full power is in use.

The consumption of coal would be 4 lbs. per hour of lighting, of water about half a gallon, of carbon about 4 inches per hour, allowing for ends wasted. Comparing with an ordinary first order light, illuminated with paraffin, the account for lower power would stand somewhat thus:—

Credit.—Oil and wicks and glass chimneys saved, an expense varying with time and place but not less than, annually	£85	0	0
Debit.—Coal, 9 tons at 25s.	£11	5	0
Wages	30	0	0
Oil and waste	6	0	0
Carbons, 1,460 ft. at £10 per 1,000 ft.	14	12	0
Extra repairs and contingencies ...	15	0	0
	£76	17	0

which suffices to show that the charges would not differ materially from an oil light. The substantial advantage resulting would be that at a trifling cost per hour there is available at any moment a light of the greatest penetrative power.

Various objections may be taken to the arrangement here proposed and collateral points be raised, and it may be convenient to anticipate some of them.

A Dowson gas plant is unsuitable to a lighthouse built upon a rock offering no space beyond that occupied by the tower. True; until there is a paraffin engine burning oils as safe as the oils now used in lighthouse lamps, it is probable that the electric light will be excluded from such stations.

Gas engines and dynamos require a different training of the attendants from that which they have acquired with lamps for oil. Again true, but it is also true that starting with fresh men it would be as easy to teach them to manage the electric plant as the highly developed burner now used. Still no one interested would desire to see the electric light introduced into any service unless the keepers were intelligent and well trained and the supervision vigilant. Indeed, the electric light should be introduced gradually into lighthouses, though not so gradually as has been the case, giving time for the lightkeepers and inspectors to gain the necessary experience.

The first object of this communication is merely to prove that the minimum cost of an electric lighthouse is not *necessarily* greater than that of an ordinary oil light.

The maximum power would not be available if the eight horse engine and dynamo from any cause failed. The engine and dynamo could, of course, be duplicated at moderate cost, about £400, but this appears hardly necessary as the small engine, though of vastly less power, is still available. The purpose of the larger light is to reduce the number of occasions on which the light ceases to be visible at a stated distance, let us say to reduce it from 50 occasions per annum to 10. If on some one occasion this were not accomplished, the mischief would be the same as if on that one occasion the atmosphere had been a little thicker. The large engine is a complete stand-by for the small one.

A question well worthy of discussion is this: in thick weather, is it desirable to direct the maximum illumination on to the nearer sea instead of the horizon? The correct answer to this question will undoubtedly depend upon the particular circumstances of each lighthouse, upon the height of the focus upon the sea and upon whether the light is for the guidance of the maritime traffic and protecting an extensive reach of coast, or whether it is primarily intended to mark some point of danger such as the Wolf Rock or the Eddystone. The presumption is in most cases against dipping the light; it implies robbing the distant sea; the keeper has to exercise his discretion from the appearance of the atmosphere in his vicinity or in particular directions, and to decide whether it is impossible that the light is reaching its advertised range; if he judges wrongly he may restrict the range of his light when it is unnecessary to do so. Some guidance may be obtained from the following considerations. With a second order light, and a continuous current of 114 ampères, practically maximum illumination will extend over a vertical angle of about 20′, and over a greater angle the illumination is not much less, we may therefore assume that at 16 below the horizon the illumination is as great as in the direction of the horizon, whatever efforts are made to concentrate on the horizon. If the focus be 100 feet above the water, the sea horizon is distant 11·6 nautical miles, and the range from a ship's deck about 15 nautical miles, but a ray dipping 10′ below the horizon will strike the sea at only 3·2 nautical miles from the lighthouse; if the focus were so changed that the light usually going to the horizon would dip 10′ below the horizon, the light which would usually strike the sea at 3·2 miles would strike that surface at 2 miles distant from the tower.

Probably the wisest solution is to duplicate the larger engine and dynamo, and in actual fog to use both engines and dynamos, and both gas producers. The resultant of 220 ampères not only has the effect of more than doubling the power, but also of increasing to a material extent the vertical divergence.

In conclusion, I would repeat the points I seek to establish. An electric light need cost no more either in first outlay or annual charges than a first-order oil lamp of ordinary construction; economy can be secured by concentrating the machinery used in ordinary weather, *i.e.*, by bringing the engine and dynamo into proximity with the arc; and it is a radical mistake to reduce the capital outlay by reducing the focal distance of the optical apparatus.

DISCUSSION.

Prof. GEORGE FORBES said he had only heard the conclusion of the paper, but he should like to emphasise most strongly the remark at the very end, that it was false economy to think of trying to diminish the size of the optical part of the apparatus, because you have so perfect a focus in the electric arc light. He remembered his attention being drawn to this point by Mr. Thomas Stevenson, of the Northern Board of Lighthouses, he having upheld that view from the earliest times of the introduction of the electric light, when one of the most important points about it was said to be that you could get your optical apparatus the size of a hat because of the small focus. Not only was this false economy, but it was the least beneficial way in which you could use it. The long focus of the optical apparatus, which was used with oil lamps and with gas lamps, and which improved them so enormously, was capable to an equal extent of improving the electric arc lamps. He wished most strongly to support the opinion expressed by Dr. Hopkinson that the optical arrangements for the electric light should be of as long focus as for oil and gas.

Prof. BARRETT said he had had no experience as to the value of the electric light in lighthouses, but he had had some experience of the value of gas for the same purpose. If not out of order in referring to the effect of gas, he might mention that during the last autumn and winter, Mr. Wigham gave him the opportunity of witnessing the extraordinary effect of his double quadriform lighthouse system of illumination. It so happened that on both evenings when the experiments were being conducted a fog intervened between the position in which he was placed and the lighthouse. On the second evening the fog was so dense that the fog siren erected at the lighthouse, and driven by a gas engine, was entirely unheard. That was a very remarkable circumstance, because he did not know that we had any evidence that the electric light would penetrate a fog of sufficient density and sufficient variation to extinguish the sound of a fog siren. There was no doubt whatever that the double quadriform light was very clearly seen, and with an opera glass the whole shape of the light could be made out very well. He thought one of the most striking features of this light was the diffused glare cast on the sky, which would create an impression on the eye when the electric light would not be seen. He had read of the South Foreland experiments, and had no doubt that they were conducted with great care; but as far as he could judge the electric light was not pitted against the highest forms of gas lighthouse system. It was very desirable that there should be comparative experiments between the highest forms of gas lighting and the best form of electric lighting for this purpose. It seemed to him a great pity that in experiments conducted with the very best form of the electric arc which could possibly be introduced there was not at the same time introduced the best form of gas lighthouse system, so as to make the comparison concl-

sive and settle the question once for all. With reference to the kinds of fog, he knew that the law being worked out now showed the intensity of the light in a fog of uniform density; but fogs were often of alternating density, and here came into play the advantage of a large diffused light such as that given by the double quadriform light. He had noticed the great value of flashes of light in arresting the attention, and he fancied if gas could be burnt from a large pipe, so that a large amount of energy could be liberated in a short space of time, then such a system in a fog might be more effective than any system of electric lighting. He suggested the use of a pipe which would emit a large amount of gas in the open air, and that might be combined with a gas gun, which might be exploded simultaneously. He was sorry something of that kind had not been tried, and was convinced that a trial ought to be given it.

Mr. WIGHAM said he must heartily concur in what had been said in the paper, and also by Prof. Forbes, with regard to the advantage of using large optical apparatus in connection with the electric light, and he was exceedingly glad to know that such a high authority as Mr. Stevenson, of Edinburgh, had pronounced in favour of long focus lenses. He had advocated this for many years before this association, and he was very glad to learn that the principle was to be adopted now. With regard to the question of first cost, Dr. Hopkinson was probably quite right, and he thought it was very desirable that they should endeavour in this powerful light to bring down the cost. Dr. Hopkinson's method of doing it, he thought, seemed promising, and if he could arrange the electric light for lighthouses in the way he proposed, by increasing the intensity in thick weather and diminishing it in clear weather, and consequently diminishing the cost in clear weather, it seemed to him a reasonable and sensible proceeding. He wished, however, to take exception to what the author said in the early part of his paper as to the undoubted fact that at the South Foreland experiments the electric light, whether in clear weather or fog, was found to be superior to the other illuminants tried. He happened to be present on one or two occasions when experiments were being made. The electric light, in clear weather, seemed to him so surpassingly splendid as to almost convey the idea that it could not possibly be beaten under any circumstances. Yet, notwithstanding that splendour, which was so great that you could read the smallest print, pick up a pin, and see the second hand of your watch, when fog intervened and that great light was looked at through the fog, one came to be surprised at the enormous extent to which the light was reduced by the fog. Mr. Harold Dixon, than whom he supposed there was not living a more careful manipulator or an observer more accurate, stated that the electric light in fog at South Foreland was, he thought, about 16 per cent. greater than that of gas and oil. Prof. Adams on the contrary, at the meeting of this association last year, said it was 60 times greater. Now 60 times greater was a very large percentage; so that between scientific gentlemen there was a divergence of opinion as to the extent to which the electric light in fog exceeded the other lights. It was incidentally stated in the paper that the electric light at South Foreland was directed, not to the illumination of the whole of the horizon as an ordinary lighthouse light would do, but was directed (not always, but on some occasions, and occasions upon which the percentage of superiority was based) upon the observers; when the position of the observers was known the electric beam was thrown upon them. When that statement was taken into consideration, as well as the very small percentage of superiority which the electric light showed according to Mr. Dixon, and when also it was remembered that at the present moment, owing to the questions put and requests made in Parliament, the Board of Trade had promised to publish the correspondence which had taken place with harbour authorities and owners and others not quite satisfied with the experiments made at South Foreland, he thought it would be well for the public, and especially the maritime public, to withhold its judgment, and not to accept as an undoubted fact that the electric light is more powerful in fog than any other light. He himself had very grave doubts.

Prof. W. GRYLLS ADAMS said he had not intended to make any remarks upon the paper, because the particular points as to cost with which it dealt he knew nothing whatever of. But one or two remarks which fell from Prof. Barrett and Mr. Wigham with direct reference to his own report on the South Foreland experiments, and which he thought quite outside the scope of the present paper, necessitated a word or so from him. With regard to Professor Barrett's remark as to the experiment when the fog was so intense that the fog siren could not be heard, he was somewhat astonished, because he thought that if we had a very thick fog indeed, still the sounds would spread well through the fog; in fact, that the fog became the medium for the conveyance of the sound from one point to another, and that, provided the fog was tolerably homogeneous, the sounds would not be thereby shut out. In this case one might gather (he did not know whether Prof. Barrett intended to convey that meaning) that the fog siren was nowhere in comparison with the brilliant light exhibited on that occasion. But he thought that the general conclusion which previous observers had arrived at was that for near distances, say not more than two miles, in the very thickest weather possible, when no light whatever would penetrate the fog, then they were dependent upon the fog siren, and under these circumstances the siren had been found effective. Experiments made upon this subject proved that fog conveyed sound remarkably well. It depended, in fact, upon the homogeneousness of the fog. With regard to Mr. Wigham's remark as to the difference between his (Prof. Adams's) report and that of Mr. Dixon, he thought there was a little mistake as to the facts. Mr. Dixon did not state that the electric light was 16 per cent. better, but that was the result of general observations made. Those figures, in fact, came from the members of the Trinity House and not from Mr. Dixon's report, and referred to the general observations made by unskilled persons in various parts whose reports had been sent in to the Trinity House. With regard to his and Mr. Dixon's reports, he must say that they agreed wonderfully with regard to the intensity of the electric light in different states of weather. There was not what might be called a serious disagreement between the reports as would appear from the figures Mr. Wigham quoted. He thought Mr. Wigham's own statement, made a moment or two before, entirely bore him out in that relation which he gave between the intensity of the electric light and the intensity of any other light experimented with, namely, that it was 60 times as bright as any other light. Mr. Wigham himself said that at very great distances from the lighthouse the light was so intense that you could see to pick up a pin.

Mr. WIGHAM: Sixty times as bright in fog, you stated.

Prof. ADAMS: I do not think I stated it so in my report. It depends upon the character of the fog. A small portion of the report taken in that way without the text may not represent the case as it actually stands. The results which I gave were the results of definite measurements of intensity of light, not any assumption whatever, but the simple result of measurement. The whole matter is fully discussed in that report, to which I would draw attention, and I think it will be found by all who consult it that there is no essential difference between Mr. Dixon's report and mine; and, in fact, we were both astonished to find such an agreement between our results. Of course Mr. Dixon's report refers to a series of experiments on one night and mine to a series of experiments on another, so that they might well appear to be different; it is very easy, in fact, to gather a leaning in one direction or in another as a person is inclined to do so without being conscious of any such leaning. Therefore, I think, if the whole report is gone through, and the general result drawn from my work and Mr. Dixon's it will be found that there is a very remarkable agreement between them, and at any rate there will be a scientific basis from which anyone can draw conclusions absolutely correct, because there are the figures given of intensities, and so on, and the circumstances under which the experiments were made.

Sir WILLIAM THOMSON said he was sorry he was not able to be present during the reading of the paper, but he could see from what he had heard, and from the short printed abstract, that the proposal was one of very great weight, and one from which they might hope to see satisfactory results in practice. With reference to the power of the electric light, he did not know whether yet an erroneous impression which got abroad from observing the lights on the Thames Embankment had been completely dispelled. Those who had been scientifically engaged upon the subject had completely done away with any wrong idea as to the relative piercing power of electric light and ordinary light, but he did not know that the results of their investigations had as yet been quite appreciated, because many people seemed to be under the impression that the electric light is less competent for penetrating fog than gas light; although the electric light may be of greatly superior power in favourable circumstances, when there is no fog, and when the great superiority is not wanted, there is an idea abroad that it loses its superiority in fog. He thought he was right in saying that the result of the investigations of Sir James Douglass and the investigations referred to by Prof. Adams generally had been to show that there is no discoverable difference in penetrating power between gas light and electric light, in a clear white fog.

The PRESIDENT (Sir James Douglass): Very small difference.

Sir WILLIAM THOMSON, continuing, said fogs at sea were white fogs, not the kind of fogs they were too familiar with in Glasgow, London, and Birmingham, in which the substance that converted the light into heat was not particles of transparent water, but sooty particles. When the fog was such as to redden the sun or moon seen through it, then in relative comparison of power gas or oil would have the superiority; but when the fog was such as to leave the sun or moon white when seen through it, there would be no perceptible difference, if any difference at all. Lord Rayleigh had given a perfect mathematical explanation of the absorbing power of fog on light, and showed why there should not be any difference in the case of white fog, although there might be a large difference in a smoky fog. Lord Rayleigh's proposition that there was no loss of light at all in white fogs seemed startling. The whole light of the lighthouse passed away as light, and none, or quite a small proportion of it, was converted into invisible heat. The light itself became invisible as a point because of the scattering of its effects, but the light was all there. The general result seemed to be this, that the loom of the electric light in white fog, though not visible as a point, might still be most valuable to the mariner. In fact, when the light itself could not be seen at all a general lighting in the sky in the direction of the light would be visible, and give a light of the usefulness required by the mariner; so that, when not seen directly at all, still there was a relative superiority of the electric light over that of gas or oil. If electric light gave 60 times as much light as oil at distances when neither one nor other could be seen, the electric light would have 60 times the power of illuminating the sky and doing what was required. He would just ask a question which probably Sir James Douglass could answer, whether the loom of the light on the sky when the light could not be seen was largely of practical importance. It certainly was under certain conditions, but he did not know whether it was so in all.

The PRESIDENT: Certainly.

Sir WILLIAM THOMSON, in conclusion, said he thought from what was stated in the paper that it was apparent that in point of economy as well as the great advantage for power in the case of fog, the electric light was commending itself more and more as a scientific result which was now ready to be put into a practical form.

Mr. MORDEY drew attention to the fact that it had for many years been the practice of lighthouse engineers to use alternate current dynamos where the electric arc was used, the experiments at the South Foreland having been carried out with such machines, which were used also at the Lizard and at other lighthouses. He was glad to see that the author recommended continuous current machines, and asked if any change was found necessary in the optical apparatus to obtain full benefit of the light from the arc. He supposed that the more even distribution of heat, and the regular consumption of the carbons with alternating currents, had enabled this method of working to survive from the early days when even fairly good generators of continuous currents were practically unknown.

Prof. BARRETT desired to make an explanation. He did not pretend to say that the gas lighthouse was superior to the fog siren in all cases. What he said was that on the particular evening on which the experiments were made the fog siren was not heard at the place of observation, although they listened for it, and the light of the quadriform was seen. The fog was probably not homogeneous. They knew it was dense round the lighthouse, because all the lights were on, and it was dense round the place at which they were making observations, six miles off, because they could not see neighbouring lights, but the intervening space might have been clear, and in a fog of that character it seemed that the quadiform light was superior to the fog siren. There was another fact he wished to emphasise, and that was that gas could be usefully employed where you could utilise a large amount of energy suddenly; a large flare of gas at intervals would produce such a glare in the sky as would be seen at great distances.

Mr. SWAN said if there was any value in the suggestion of Prof. Barrett to produce a very powerful, intermittent gaslight, he thought it was quite possible that a similar effect might be obtained through the mediation of the electrical accumulator with the electric light.

Mr. BIGGS said there was a reason why a certain admiral did not fire a salute, and perhaps the reason why the siren was not heard on that particular night was that the siren was not going.

Mr. KENWARD, who, in the absence of Dr. Hopkinson, read the paper, in replying, said Sir William Thomson had asked if any practical results had been obtained with regard to the use of the luminous glare reflected by the electric light on the clouds. He could give one notable instance where it had been of great service. At the present moment the largest lighthouse apparatus in the world was that in the Macquarie Light at Sidney Heads, erected by the enterprising colony of New South Wales. The principle was at first strongly deprecated and viewed with remarkable suspicion, but now there was ample practical illustration of its usefulness. Mariners had reported that the luminous glare had been seen at 60 miles distance and had been accordingly of great use to vessels in the far distance, which had been able to get a sort of *avant courier* of the coming on of the direct light. This experience had been borne out in other cases, and the sky-glare might be regarded as a useful factor in lighthouse economics.

The PRESIDENT said before calling on the Section to accord Dr. Hopkinson a hearty vote of thanks for his very valuable paper, he would himself offer a few observations. Having been engaged for a great many years on lighthouse engineering, and being somewhat connected with the South Forland experiments, in which he was ably assisted in his portion of the work by Prof. Adams, Mr. Harold Dixon, Mr. Vernon Harcourt and others, he would make a few remarks upon what was done there. Dr. Hopkinson had brought forward a very important subject in connection with electric lighting as applied to lighthouse illumination; he had attempted to show them—for he (the president) was not quite sure that he had succeeded—that he was able under nearly all conditions of ordinary lighthouse illumination, to bring the electric light into competition with gas and oil. He had entered upon a difficult path, because it was perhaps one of the most difficult applications in which to compete. They were dealing with smaller installations in many cases; in all cases they were dealing with an individual installation and a smallish one, they were dealing with it in an isolated position, and sometimes in places of great difficulty. They all felt that mineral oil was difficult to compete with, because it was the simplest and the cheapest method. He remembered paying 6s. 8d. per gallon for sperm oil; they could now obtain a superior oil to the sperm at 6d. per gallon. He was a bold man who would attempt to light a lighthouse with electricity against oil at 6d. a gallon. He need not refer to the price of coal gas, as that was well known. In connection with the South Foreland experiments, they had with oil and gas gone to powers 10 to 15 times greater with the single illuminant than they had a few years ago, even so recently as the French Exhibition of 1867. Electricity had been going on in a greater ratio, and it was now determined by those who had charge of the experiments at South Foreland, it had been determined by the Trinity House, with which scientific men in all parts of the world connected with lighthouse authorities agreed, that at the present moment oil and gas reached an intensity equal to the ordinary requirements of the mariner. In narrow waters you could very easily overdose him with light, and there were instances recorded in which they were told that the light was too strong, and the seaman actually begged them to reduce its intensity. He never said that, however, in thick weather, but in clear, fine weather it was not necessary to have so good a light. It was out of the question to think of competing with the electric light by means of oil and gas. They had at the South Foreland put into an arc an energy equal to twenty times that of anything yet done with oil or gas. Although they had progressed so far with oil and gas, electricity was very far ahead. Another point, they had an intensity 200 times the initial intensity per square inch of focal area. Therefore, anyone could appreciate the advantage of the electric light. It was true, as Mr. Wigham observed, that this apparatus was at the Foreland frequently focussed on the nearest observer. But it was to be remembered that the apparatus were experimental, and therefore at times were set at particular points of observation. That to his mind was one of the merits of the electric light, where you had a small arc which you could adapt to any circumstances, and which would not be robbing the mariner of any portion, giving him in thick weather the utmost intensity of the light in the position in which he would expect to find it. Prof. Barrett referred to a case where the fog siren was not heard when the gaslight was seen. That must have been a very poor siren, because the siren should be heard under any circumstances in fog two or three miles. Quite true it was one of the most disappointing instruments he had had to deal with. They had had sirens at work where they had 150 horse-power into the beam of sound, and yet that sound at times was not heard a mile. Generally in fog it was heard two, three, or four miles. He would tell them of an occurrence at the South Foreland which they would possibly have some difficulty in believing. On one occasion in a thick fog they were turned out, as they were subject to be at any hour of the night during fog, between one and two in the morning. There was a very thick fog, and they had to walk up to within half a mile of the lights before they saw them; at that moment they were hearing the South Sand Head fog siren at a distance of three miles clearly. It occurred to him, why waste this light when this, one of our feeblest sirens, with only 1¼ brake horse-power gives us a sound so intelligible. Several vessels in the offing, nearer to them, they could hear clearly. This was very singular; there must have been a very different state of things or else the instruments must all be different. Another point was referred to by Mr. Wigham, and it was not the first time it had been referred to. When they commenced the experiments at South Foreland it was intended that each of the illuminants, mineral oil, gas and electricity, should do its very best. Mr. Wigham suggested four illuminants, a superposed apparatus and four elements, four of the largest burners and four lenses, all superposed. He (the President) contented himself with superposing three oil lamps, and they prepared three for the electric light. They expected at the time that they would place all their energy in one arc, but it was thought desirable to determine the question as to whether it was most economical to place all the light in one or in two or three arcs. They soon found that they could work the one electric arc with all their energy most efficiently in one focus, and in an apparatus of the second size, of 720 millimetres focal distance. That size of apparatus had for the present been determined upon. That, he might remind them, was an important question. It was not absolutely necessary that they should have the second order of apparatus for the electric arc. The French contented themselves with the fourth order; they had gone from the sixth to the fourth, and possibly they would go further. But it was desirable, for the perfect manipulation of the light, that the keeper should enter the apparatus, and the second order size was just sufficient. If the second order of apparatus, with such a pair of carbons in focus as those he now exhibited, would meet all the requirements as to the necessary duration of the flashes—for that was important; if you had not the necessary length of flash of course you required a smaller apparatus—if that was sufficient to meet all the requirements, any enlargement of that apparatus was a positive waste of money. With regard to the question of direct and alternating currents, there was a crater produced in the carbon by the alternating current; if they worked with a direct current the crater in one carbon would be very much larger than that in the other. It was very evident if they placed the two together in the way he indicated, the best part of the light would lie locked up in the crater. Even with the single crater with the direct current there must be a great deal of light lost. He had lately been making experiments with carbons fluted, for which he thought there was a great future. By using a fluted carbon they abolished the crater altogether, and one very important point was gained. He produced a model of a carbon which had been at work with an arc of 30,000 candles. The walls of the crater were completely licked or eaten away by the attack made upon it in the flutes. Then, again, which was another very important point, they had the arc held centrally in the carbon. That, for lighthouse illumination, was a very important matter. Any departure from the central position of the carbon sometimes affected the duration of the flashes considerably. A flash might begin too soon and end too soon, or it might begin too late, or it might be too much prolonged; when prolonged it was considerably weaker, unfortunately, and therefore the flash might be lost entirely from want of intensity. Then, again, nothing, to his mind, could be more perfect than the luminary formed by a pair of these carbons. You had there a luminary perfect as regards its focal compactness, and perfectly central, and with a largely increased radiation vertically by the light which passed between the flutes above and below, compared

with the solid carbon. Then, again, they found the carbon was cooler; the heat was localised at the point—so much the better for the lamp, which had been a great trouble to them, in consequence of its conductivity of heat preventing its free action. The President concluded by moving a vote of thanks to Dr. Hopkinson, which was heartily accorded.

DYNAMOS FOR ELECTRO METALLURGY.

By Prof. GEORGE FORBES, F.R.S.

(Section G.—Mechanical Science.—Monday, September 6th.)

AFTER pointing out that the attention of electric light engineers had of late been much directed towards the application of dynamo machines to electrolytic industries, the author said that his original intention had been to raise a discussion on the whole question of electro metallurgy. As it was quite impossible, however, to do any justice to such a subject during the limited time at the disposal of the meeting, he would confine himself to a mere description of a form of dynamo which he had designed, and which was specially adapted for this class of work. The machine, which is already well known, need not be described here; we therefore omit this portion of Prof. Forbes's remarks. In speaking of the future of electrolytic industries, the author stated as his opinion that copper utensils, such as were now made by more or less complicated processes, would, ere long, be made by electro deposition at one-tenth or one-twentieth the present cost.

Mr. SWAN: In this low tension dynamo which Prof. Forbes has described to us, it seems to me he has, with a great degree of success, accomplished the difficult feat of combining the *real* and the *ideal*. Prof. Forbes's dynamo is almost ideal in its simplicity, it is almost ideal in the complete utilisation of all the magnetic rays, and it is ideal in the almost entire absence of resistance in that part of the machine which corresponds with the armature in the ordinary dynamo. It is interesting in many ways. It is interesting as a development of Faraday's first idea of a dynamo; it is especially interesting in connection with the copper industries of Birmingham, for it seems to afford an unlimitied power of depositing copper, for, as was pointed out by Prof. Forbes, there is not a form, however complex, which copper may not most easily be made to assume by electro deposition. When it becomes understood by manufacturers how small an amount of electrical energy is required to effect the deposition of copper in every variety of form, and in the largest and heaviest masses, I cannot doubt that this mode of working copper will greatly extend in this centre of metallurgical industry, and I think we may hope that in that extension the electrical generator which Prof. Forbes has described will play an important part.

Mr. W. M. MORDEY asked if Prof. Forbes had ever tried to avoid the difficulties of collection by revolving those parts of the machine which corresponded to the "field" in ordinary dynamos, and keeping the central part fixed.

Mr. WILLIAM ANDERSON drew attention to the applicability of the process to the coating of piston rods with copper. This was an important operation, and was attended with some difficulty.

Prof. FORBES said, in answer to Mr. Mordey, that if the point was considered, it would be found quite impossible to collect from a stationary mass. The reason was that the collector itself would be cut by negative lines, and E.M.F. would be induced in an opposing direction to that in the armature, which would exactly neutralise the latter.

ON THE NECESSITY OF PROTECTING TELEPHONE EXCHANGES, CIRCUITS AND APPLIANCES FROM THE DESTRUCTIVE EFFECTS OF INTENSE ELECTRIC CURRENTS AND DISCHARGES.*

By T. D. LOCKWOOD.

IN the younger days of telephony and telephonic utilisation, when we too were younger, to write a paper or an article upon the intricacies of the telephone, the central office, the signalling and induction neutralising appliances was for me an easy operation. I am sure that the majority of you will agree with me that it is a comparatively light undertaking to write an instructive article upon a subject of which we know little or nothing, and to dilate learnedly upon the causes, near or remote, of phenomena with which we only have a bowing acquaintance, but as we and our business grow older we grow more cautious about making assertions, and do not especially yearn to air our superficial knowledge; consequently when in the palmy days of telephony my pen was accustomed to scratch off from twelve to fourteen pages of foolscap per week, it was less of a task than it now is merely to choose a subject to write about, and when I occasionally throw a retrospective eye over the statements which unscrupulous publishers have ascribed to me, I rather wonder on the whole that I made so few mistakes. I hesitated considerably before consenting to commit myself to a paper for the Association, and when our honourable secretary asked me directly if I would furnish a paper, I am afraid that I only said "I would try," from a constitutional disability to say "No." Still we have it on the very highest authority—as General Butler would say—that "Fools rush in where angels fear to tread," and after long and painful cogitation, I chose the subject with the long title which I have read to you, principally, I grieve to say, for the lamentably insufficient reason that, upon looking over the association records, I found, or thought I found, that it was as unhackneyed as any I could pitch upon, unless I switched off from the realm of applied electricity into "methods of book-keeping—toll *versus* lump-charge," or some other of those lay investigations of which electricians and electrical engineers are supposed to know nothing.

I have in the title of my paper referred both to intense electric currents and discharges. It may be said that the terms "currents" and "discharges" are synonymous. And indeed the difference is only one of degree; but for the purpose of this paper I have assumed a current of electricity to be an electrical excitement in a linear conductor of comparatively controllable force, so that it is actually dependent for its existence upon a circuit of some sort, and which consequently ceases to be, when that circuit is broken or impaired.

Per contra: I choose to regard a "discharge," or more properly a "disruptive discharge," of electricity as a form of electrical excitement which is not dependent upon the palpable continuity of a circuit, and which, as in the lightning flash, has a sufficient force of its own to leap an air space or to traverse an extremely poor conductor which may intervene in its direct and devastating career.

There is, I hope, little need that I should emphasise the necessity of protecting our circuits and apparatus from the destructive effects of these currents and discharges.

It would not be hard for me to believe that every exchange represented at this meeting has directly or indirectly, in a greater or less degree, suffered from this cause. When the business was in its first and second years, we heard little of damage and loss, fairly to be ascribed to abnormal electrical currents and discharges. The electric light then existed only in a sporadic state. As recently as July 4th, 1876, it was counted a startling novelty not to be repeated hastily, to show an arc light upon the Western Union New York tower; and we were just beginning to hear of Brush, and to get a hazy idea that the Brush machine was so named, because possibly there were more brushes on its commutator than on the average machine; and that the Gramme machine owed its patronymic in some vague and unaccountable way to the centimetre-gramme-second system of units. Even the summer lightning storm scarcely seemed at that early time to have acquired the prevalency, fierceness, and the ability of getting in its work, that it has assumed in late years. I imagine, however, that the immunity we then apparently enjoyed is to be ascribed first of all to the small number of exchanges, circuits, and telephones in existence, and the probability is that all things being equal, the mortality of telephonic appliances from this disease was not much less in proportion to the number of instruments in use than it is now. At that time, too, the battery transmitter was not so universally employed, and the magneto bell was not, therefore, so complicated in its switch connections, while the telephones, when not actually being used, were completely cut off from the circuit. By the end of 1881, however, we began to ascertain by bitter experience, that throughout the United States (with the exception of the entire city of Philadelphia) lightning was a factor among the destructive agencies at work against telephone plants, which had to be counted upon. With respect to the remarkable exemption from disaster due to this cause enjoyed by Philadelphia, I am constrained, after careful consideration, to believe that it can only be ascribed to the existence of the same conditions which in ages gone by would have saved Sodom, to wit, the residence there of not less than 10 righteous men. The destruction of telephone apparatus at this period was quite noticeable, and curiously enough, that portion of the apparatus which seemed to suffer the most heavily was the transmitter induction coil; and this seemed the more singular in view of the fact that this portion of the instrument was assumed to be in circuit only during the actual occurrence of conversation, and to be totally disconnected by the automatic switch during the long and frequent intervening periods of quiescence. This was ultimately accounted for by the circumstance that the older magneto bells had but one binding screw for their local battery connection, and it was customary for the person connecting them to attach the other battery wire into one of the main line connection screws. This, of course, left one end of the primary helix of the transmitter coil always in connection with the line, and in the event of the line receiving a lightning discharge, a portion of it would frequently seek earth through the primary helix and across the insulation to the secondary, burning both out in transit. The practice of connecting the battery wires in this fashion was very generally discontinued after this discovery, and the bells later were differently arranged, so that this danger was subsequently minimised.

By the beginning of 1882, electric light plants were fairly established in most of our large cities, and from that time to the present they have been a constantly increasing quantity. Very few cities of any importance are now without their electric arc light system, and as a natural consequence very few telephone exchanges are in a position to assume that they are not, and cannot be liable to a danger due to a cross between the two classes of conductors. This source of dangerous currents has in fact completely overshadowed the older and more natural exposition of electrical fire-

* Read before the American National Electrical Association.

works, and it behoves us to look the danger in the face, to prepare for the catastrophe which may never come—and to prevent it, if possible. Not that lightning does not even now scatter destruction along its path; not that we must fear and guard against the lightning discharge less; but that we must look out for, and guard against, the adverse electric lighting current more. Of course every telephone exchange manager hopes and believes that everybody else's plant will suffer before the danger comes nigh him, but it is just as much a truism now as in the days of the wise, but uxorious Solomon, that "the prudent man seeth the evil and hideth himself, but the foolish pass on and are punished." The Gaul in his own habit of thinking points a moral by the aphorism that "It is always the unexpected that happens," while the more calculating Teuton shows his views by the cautious statement "Then you must look oud." We are not without examples of costly ruin in telephone property from the causes I am speaking about, and I think I am justified in believing that the instances made public are few in number, compared to those which have remained in obscurity, although perhaps more far-reaching in importance and more extensive in intrinsic value. Boston, New Orleans, Toronto and other places have had central offices gutted from electric light currents. Omaha has I understand, suffered dreadfully from lightning, and the isolated cases where single subscribers' outfits have been destroyed and annunciator drops damaged, have even within my own limited observation been of great frequency. What then are we doing, or going to do about it? Were these places warned of the destruction before them? Some of them were to my certain knowledge both by example and precept. I myself have lifted up the voice of warning to protect both ends of the telephone circuit; and in one or two instances have been laughed at and called an alarmist. In the case of Boston several small conflagrations took place, bells were burnt out, and sections of cable were destroyed before the grand stroke came, but the warning was not taken and the Boston central office was burned. The result was not altogether without benefit, for the central office in that city has, I believe, not a single wire entering, which is now unprotected at the office end; showing that its managers have at least in some measure profited by experience. Again, I ask, what are we doing, or what can we do, to prevent or diminish destruction from these devastating influences?

With respect to lightning, we cannot do much more than we are, and have been, doing for a long time. We should protect our central offices as far as possible, I think, by providing them with a high projecting and thick copper lightning rod, stretching far down into the earth, not fastened to the building by little rings of glass, in the style adopted by the peripatetic lightning rod man, but stapled to the building itself, for it *is* possible that a discharge of lightning might find an opportunity, having struck the building, to escape by way of the rod; but it is not conceivable that a discharge of electricity traversing the rod could be lightly induced to forsake good honest copper for bricks or wood. If any lightning can be found with such dishonest and illegitimate propensities, we may rest assured that little glass insulating rings will exercise no restraining power on it. We should be liberal in the size of our ground wires, both in central and subscribers' stations. Too often the terminal ground at the end of a subscriber's line is nothing but a flimsy No. 18 S. W. G. copper wire, twisted three times round an unscrapped gas-pipe. We should insist upon better lightning arresters at the central station for each line. The best, I think, is a kind which I do not often see—namely, a form in which advantage is taken of the habit of high-tension electricity to pass promptly from a point to a plate. Now, as my experience leads me to believe that damages are due to an equalising discharge from the earth about as often as from the direct stroke, I hold that both points and plate surfaces should be provided for both sides of the lightning arrester, so that discharge in either direction may be facilitated. Let us now consider the electric currents. Perfect security will only be achieved from dynamo currents when the electric light and telepone companies shall combine for the best interests of both; when both learn to see that a disaster to one is in but a less degree a disaster to the other; when the lineman of one company shall cease to regard the presence of another company's wires at any point or place as a personal insult, and as a sufficient reason for them to be elsewhere; when electric light companies will refrain from using wire unless it be insulated with an insulating material instead of with a covering only; and when telephone linemen will have no serious objection to going a foot or two out of the preordained route, when they come near to an electric light or power wire. Failing, however, to attain perfect security, the next best thing is as perfect security as we can attain. To gain this we require, first, a thorough grade of construction; we need also some efficient automatically operating protector, not only at the central office end of every line, but also one for each wire where the conductors emerge from the cable, if an outgoing cable is used. These precautions are to defend the cables and the central station apparatus. What availeth it, however, if the central station and connecting wires are saved, if but one subscriber's station be destroyed? And if subscribers' stations are left unprotected, who dare say that even to-morrow the powerful electric lightning current by some accident may not (and the more likely if the central station end is fully protected) pass along the subscriber's line and destroy his instruments, or what assurance have we, should such a thing happen, that the telephone instruments will be the only articles burned?

One fire caused by an electric light current entering a subscriber's house or office, if it should be at all serious, would be a worse blow to any telephone company than a dozen affecting the central office or conductors only. This is no vain caution. I have thought deeply of what I say, and I repeat that where the electric light wires parallel and intersect the telephone wires in our streets, that telephone is barely half protected against the heating effects of electric currents that has a protector at the office or cable end of each wire only. This applies, of course, equally to private lines. Even while I am penning these lines, I am informed that a private line leading out of this office has had all four of its bells burned out, all of which might have been saved had each station been fitted with protectors. If a cable occupies an intermediate position, its wires, in my opinion, require protectors at both ends of the cable. The question now arises, what form of protector is to be used? Two broad and comprehensive classes are more or less known—viz., those in which a coarse wire electro-magnet included in the telephone circuit at the points to be protected is used to break the circuit or shunt the instruments upon the passage of an abnormally strong current through the wires, the magnet being non-operative when the ordinary telephone or magneto currents are passing; second, those in which an attenuating strip of metal foil or wire is made to form a part of the circuit outside of the portion to be protected, this having a sufficient conductivity for the ordinary currents, but being adapted to burn out, fuse, volatilise or deflagrate, when a dangerous current passes.

Both of these classes may again have diverse functions. They may, for example, be adapted to simply break the circuit, producing a space so wide that the current cannot overleap it, notwithstanding its great electromotive force; or they may be adapted to open the circuit, and then to put one or both of the severed ends to earth, for the escape of the electricity. Each have their weak and their strong points. Protectors depending for their action upon electro-magnets are reasonably sure in their action, and are prompt because the magnetising effect of a current is swifter than its heating effect. On the other hand, electro-magnets in telephonic circuits interpose a much higher opposition to the passage of the telephonic current than might be expected from their resistance only, by reason of the counter-currents generated in their coils by the changes in their magnetism; and electro-magnetic appliances, irrespective of their simplicity, are necessarily higher in first cost than are the fusible protectors. It is proper, however, to state here that magnets of such low resistance as is required for these appliances are not extremely troublesome in the first respect. It is rather remarkable that one of the first lightning arresters used in connection with telegraph lines in the United States consisted of a coarse wire magnet through which the main circuit led to the regular instruments, and which was provided with an armature and contact points; the armature was connected with a branch wire leading from the circuit wire and ordinarily open, and the fixed contact point was united to a ground wire. When a heavy discharge of lightning came along, the magnet was for a moment vitalised, and attracting its armature connected the line instantly but temporarily to earth, thus discharging the line. This was devised by Mr. J. D. Reid, who is still, I believe, connected with the Western Union Telegraph Company.

The most effective appliance of this class, in my opinion, is the simple arrangement invented by Dr. S. M. Plush, general manager of the Philadelphia Bell Telephone Company, and comprising a small electro-magnet mounted on an insulating base; this is provided with an armature, as usual, and the armature has a lever ending in a catch which, when at rest, holds a spring lever in place. The circuit is led through the magnet coil, armature lever and spring lever, so that when the armature is attracted the spring lever is liberated and flies back, leaving an opening of some six or seven inches in the circuit, and preventing damage to the instruments inside of the safety appliance. I have heard nothing but good of this appliance. It is extensively used in Philadelphia, and I regard it as being a very efficient protector indeed, and its first failure has yet to be heard of. The worst thing that can be said of it is, that after one is opened it has to be manually attended to before the circuit can be used. Like all other electrical appliances, it requires to be well made to give good work.

Other electro-magnetic devices have been invented of various kinds and for various auxiliary purposes; for example, one is so arranged that it grounds the circuit through contact points as long as the dangerous current is passing, and restores the original state of things when the danger is over. This is done by winding the magnet with two wires—a coarse and fine one, as in the Brush lamp. Both wires are at first in the circuit, but the arrival of a dangerous current excites the magnet core, first by an increased current in the fine wire, and then by the coarse wire coil, and attracts an armature that remains irresponsive to the telephonic currents. When this armature is fully attracted it shunts the fine wire coil and grounds the line and the instruments until the danger is over, when the armature spontaneously falls back, restoring the normal condition. The use of the fine wire is to excite the core and operate the armature, even though the current be not sufficiently high to operate through the coarse coil at first. Still another form uses the end of the iron core as the ground contact. Another combines this general form of protector, with an electric bell to indicate the occurrence of danger audibly. My own idea is, however, that appliances for the purpose cannot be too simply made, and that we, as a rule, multiply complication in direct ratio to the multiplication of functions.

Referring again to the fusible link protectors; it is no new idea to use fusible wires and strips as lightning arresters. But they

were not readily adapted to telephony. These, too, have their own vices and virtues. They are, for example, too susceptible to even the smallest lightning storm; for after every storm a number have to be replaced (that is, if tin foil be used). The tin foil protectors are also somewhat difficult to mount, so as to make a good connection with the line wire, and it is not an easy matter to provide just the thickness and width of foil that will fuse or give way with currents which are of medium intensity, and these currents are the most dangerous, because with them the wires heat gradually and are liable to keep the insulation of the wires just at a smoldering heat for a long time before they finally break into a blaze. Yet, fusible links are cheap; they cannot generate counter electromotive forces, and if mounted by the manufacturer into a complete appliance prior to attachment, they are easy to attach. It must be remembered that fusible protectors need not necessarily be made of tinfoil. Lead foil or wire or fusible alloy strips can and have been used. Very fine wires, say, about No. 40 of iron, and German silver have been used; and it is matter of history that the New Orleans exchange, as early as the period when it was managed by W. H. Bofinger, employed platinum wire protectors not only at the central station, but also at the subscriber's end of the line. So many differing and adventitious circumstances enter into individual cases that it is impossible for me to say arbitrarily that tinfoil is better than fine wire, or *vice versa*. One dynamo, for example, may be a 40-lamp, another a 20-lamp, and still another a 10-lamp machine, and a wire of high resistance which would instantly volatilise with the first machine might not even redden with the last. The main point which I desire to accentuate is, recapitulating the subject of my paper, "the necessity of protecting telephone exchanges, circuits and appliances from the destructive effects of intense electric currents and discharges;" the necessity of some form of protection, whether it be electro-magnetic or fusible, and the equal necessity of protecting both ends of the circuit with equal diligence and care. This much may be said in favour of the fine wire (and for the material I prefer German silver), that it is easier applied than any other form, all the essential features being two screws, a pair of copper burrs on each, and about five inches of fine wire twisted round each screw. I have no objection also to say that my own personal preference is for a well-made Plush electro-magnetic protector.

I think a few words on the question whether it be best to *open* a circuit crossed with an electric light wire, or whether it should be grounded by the action of the protector may not be amiss. While I believe the first thought of most persons would be to ground the circuit, I believe also that the sober second thought would be in favour of opening. For these reasons the circuit, once opened, is innocuous; the current, so far as that line is concerned, has softly and suddenly vanished away, like the gentleman who hunted a snark and found it a boojum, and it is, in fact, *non est*. But if the protecting appliance act to ground the circuit or merely to shunt the instruments, not only is there likely to be a dangerous spark and flash at the contacts, but the current is still there—there to complete its murderous and incendiary work the first chance it gets; there to pass on to the next station and to repeat its wayward performances. There is, furthermore, another point we cannot overlook—placing a grounding appliance upon our circuits may, if it comes into action, endanger the life and health of the dynamo machine itself by short-circuiting, and thus render still more untractable the already uncanny electric light man. During the last three or four years a great number of protecting appliances have been patented, and a great number of promoters and organisers have tried to organise stock companies based upon the merits of this protector or that protector, of course with the object of selling the stock and then looking for other worlds to protect. These companies are good things to fight shy of. There is not enough, even in a meritorious protector or in a meritorious individual signal instrument, to found a stock company on, and I have seen the rise, decline and fall of many such organisations. There is still another feature of this subject which needs attention. This is the line wire itself. The telephone line should not be supported near the electric light wire, it should rather be strung over a circuitous route. Where the telephone wire crosses or is crossed by electric light wires it is a good idea to encase it in a split tube of wood or like material, the two halves being fastened together by screws or wires. This simple precaution may prevent a serious loss.

I hope I have laid this subject forcibly before you. There is no telephone company so poor that it cannot at least afford the simple wire protector; none so rich that it can afford the loss of its own central station or the store or office of its patrons. No telephone manager should, in my humble opinion, be satisfied with less than the best. It may be that all the exchanges of all the licensees of the American Bell Telephone Company are already fitted with protectors. I sent out no letters of enquiry, because I have before this year been upon committees, and I know the general futility of such enquiries; still I could wish that such a satisfactory state of affairs existed. I fear, however, it does not. If, then, this paper gives rise to serious thought upon the subject, I shall be repaid for the labour I have bestowed upon it, and for the pain which I sympathetically suffer in inflicting it upon you. I will conclude by stating that I looked through the published proceedings of this association before writing this paper, and found that there was nothing exactly like it before; but I may also say, that it well repays anyone to frequently re-peruse these proceedings, and that one who has only read his annual copy once and has then shelved it, will be surprised to find the immense amount of information and detailed experience which is embodied therein. Since finishing this paper I have become more firmly impressed with the idea that the tin-foil protector is not as well adapted even for the subscriber's station as it is for the central stations. We have just passed through the summer season, and it is true, although 'tis also a pity, that not a lightning storm can occur or has occurred in Boston without disrupting a great number of these protectors. This effect is bad enough at the central station, but would be much more troublesome occurring at a number of, say 50, subscribers' stations simultaneously, and for this reason I am disposed to believe that an electro-magnetic protector that opens the circuit will generally be more satisfactory than a foil protector.

ON THE TRANSMISSION OF POWER TO THE DYNAMO.*

By JAMES A. PENTZ.

To make electric lighting commercially successful, three things are necessary:—

Steam must be generated as cheaply as possible.

It must be transmitted economically, and

The apparatus comprising the entire plant for the production of the electric current and its delivery to the circuits must be of the best.

To the consideration of the second proposition this paper is addressed.

First of all, the following statement will be conceded by everyone present:—We cannot get power through complicated machinery economically. Nor yet is the simplest motor the best one to use when its running expenses are considered.

Plainly stated, if the steam could blow directly upon a wheel without piston or valve gear, as the wind does upon a windmill, which we may say is secured upon the dynamo shaft, the problem would be solved, provided the power could be employed in this way as cheaply and as conveniently as is usually done through a more complicated piece of machinery, called a steam engine. But inasmuch as this system has been tried in many ways, and found not to answer, we must look to other methods nearest approaching the cheapest way as concerning the cost of transmission, regarding less, however, the first cost of the motor.

Without going into a discussion on the merits of the different kinds of engines, which would be without end, the statement is perfectly safe to make, that the fixed cylinder engine driving on a revolving crank pin, is, all things considered, the best. This conclusion has been arrived at after fortunes have been spent upon the steam wheel, the rotary engine, and the oscillating cylinder engine, in futile attempts at making any one of them a successful motor from a commercial point of view, whatever they may have been mechanically.

There are so many things to seek for and inquire about in the subject-matter before us, of such vital importance, that we cannot afford to review it hurriedly. It has not yet received full attention, and as this very important branch of mechanical engineering is not considered as it deserves to be, it may be well to take in some of the points bearing directly upon it, and calmly and without bias look into those factors that have a direct bearing upon its solution.

In treating this question, it is well understood that prejudices will have to be combated and removed, for there are many who, without having looked thoroughly into the subject, are following too closely merely first-tried, unimproved methods, when better ones are to be had for the searching.

The first essential in the employment of power is to get it transferred to the dynamo by means of, and through, the least number of organs of transmission; and it is likewise important to do it mechanically, in the most direct manner.

This brings us face to face with the high-speed engine, and the one-belt method of power transmission from the engine-pulley to the pulley of the dynamo as the simplest and the best.

Countershafts as applied to electric lighting are quite unnecessary. They require more space than is usually allotted to the driving plant, adding also to its first cost and to the cost of keeping them in good working order. Any increase in shafting and pulleys must require additional attention, and, furthermore, additional power to drive them, thereby lessening the effective force of the engine.

A few tests of shafts are given herewith, to reinforce the general statement just made.

Fifty-five carefully made experiments† on factory engines, developing under full load from 46 H.P. to 1,485 H.P., showed the percentum of the extremes of resistance of engines and shafting to full load to be from 16·5 per cent. to 39·2 per cent. of the H.P., and an average of 25·9 per cent. of the H.P., while that of the engine alone averaged about 7 per cent.

In another series of eight tests of factory engines, the average proved to be 22 per cent., and in another case, where the total H.P. employed was but 120, the resistance amounted to 33 per cent.

* Read before the National Electric Light Association, Detroit, September 2nd, 1886.

† Reported by Mr. John T. Heathorne.

If, then, all these drawbacks are to be found in counter-shafting, it should be dispensed with and some good plan produced whereby electric light plants may be run more economically.

No doubt plants run by low-speed engines driving to a counter-shaft have given good results, but if we can do better without this useless auxiliary had we not better do so?

It brings us not only to the discussion of the benefits to be derived by belting direct from the engine pulley to the dynamo pulley, but to the superiority of the high-speed engine in connection with electric lighting.

In the employment of this type of engine we gain these points:

I. Economy of fuel and space occupied by the plant.

II. Economy in first cost of the plant.

III. Uniformity of speed and regulation.

IV. Reduction of cost of repairs and maintenance.

Engines of this type must be of the best material and workmanship to ensure good running and long life, and should be of ample weight. There should not be the slightest deflection or tremor in the bed under the most trying conditions consequent upon the greatest variation in the load.

The revolving parts must be correctly balanced; the reciprocating parts light and strong; the bearings of proper materials and of ample size; the lubrication automatic, and the parts containing steam should be well clothed to prevent loss by radiation.

The steam in these engines is utilised in the cylinder to much better advantage than in the cylinders of engines running at low speed, and for obvious reasons.

It is a well-known fact that steam must be used as quickly as possible after it is generated, to avoid loss of efficiency by condensation and radiation of the heat, which is very rapid from the pipes and vessels containing it, as they are usually made and employed.

In the early use of steam in running engines, which were necessarily of slow speed, steam jackets were found absolutely indispensable to the proper action of the engine, but later practice with moderately-speeded engines has shown the warming of steam cylinders by jackets to be unnecessary.

The modern high-speed engine uses the steam as quickly as possible after it is generated, reducing the time of its transmission to the engine to the least, by which the loss of heat is reduced to a minimum. The saving from this source alone is considerable, and as the steam cylinders of high-speed engines are small in proportion to their power, the losses by reduction of cooling surfaces become smaller also.

The economy of fuel as bearing directly upon the engine may be said to begin at this point, and is carried higher by the nearer approach to perfect regulation given by the engine.

The action of the governor of the high-speed engine being quicker, the steam is controlled more easily and the speed of the engine more readily kept uniform.

It has been stated that the friction of the engine is increased when it is run at high speed, but recent experiments made at Cornell University under directions of Prof. Thurston, and with a modern high-speed engine, clearly demonstated that such is not the case.

Mr. Morin's Third Law of Friction reads, "That friction is independent of the velocity of motion."* This was announced by him and deduced from his exhaustive experiments made during the year 1834, and this law has been generally accepted by engineers since.

Attention may also be called to the test of a steam engine at the American Institute two years ago. In this test the engine was found to work through a large range of power, with little or absolutely no increase of friction. There were no extraneous conditions that would modify results, and in the machine itself nothing but ample, well-fitted bearing surfaces. According to the generally accepted laws, friction ought to have increased with the load, but numerous careful experiments showed that it did not.

We now come to the most efficient, economical and decidedly the most satisfactory method of dealing with this question, that of belting direct from the driving pulley of the engines to the dynamo pulley. By this means the connection between the engine and the dynamo is single and direct.

With the best of dynamos, when driven by engines well adapted to the purpose, good belting is necessary to the securing of uniform results.

A case occurred at the Electrical Exhibition, held in Philadelphia two years ago, which will illustrate this point. While the tests were being conducted, a tremor of the lights was observed, which was at once attributed to the engine driving the dynamo.

The fluctuations of the lights were observed to occur in times whose periods were measured by several revolutions of the engine.

The engine was at once thoroughly examined, even to the removal of the governor, which was overhauled and retested by the regular appliances at the shop, but the search revealed nothing that would explain the cause of the disturbance, for the governor was found to be without defect.

The whole trouble was discovered afterwards to be caused by the belt lacing, which, in passing over the dynamo pulley, jerked the belt, and effected the results in lighting.

Belts for driving dynamos should, therefore, be made of the best material, of uniform thickness and density and practically straight in their run through the air and over the pulleys. They should be soft and pliable and kept so by proper application of the usual and obtainable unguents prepared for this purpose.

In the use of belts for driving dynamos, they should be made endless, that is, without laced or other unevenly made joints, and when made of double thickness, care should be taken to select such makes as will give an even and full contact surface of the leather constantly to the faces of the pulleys.

Large-headed copper rivets should be avoided, because they reduce the contact surface of the belts, and coarse stitching and knots should not be used, because they destroy the smoothness of the belt's surfaces. Both diminish the adherence of the belt upon the pulleys.

The best form of engine to drive one or two dynamos, is that in which the steam acts upon a centre crank, with ample shaft bearings on each side, and with the pulleys on overhanging shaft ends.

From each of these pulleys a belt is run to the dynamo pulley. Either belt may be removed by hand when one dynamo only is required to be run.

Where the number of dynamos required is more than two, the simplest method of belting direct to the dynamos is to use two engines, made right and left, set parallel with each other, and with the main shaft connected to, and running in line, with both engine shafts, supported by proper intermediate bearings from the floor. This practically makes it the same as if the engine shafts were extended, and is usually of the same diameter. This being practically inflexible, and running at the same speed as the engine, makes it an easy matter to belt from the pulleys which it supports to the pulleys of the dynamos, thereby delivering the power, with least loss to the electric machinery, direct.

Each pulley on this shaft can be made independent, running by a friction clutch, so that, if by any reason a certain dynamo is not required to be run, it can be stopped, and without interfering with the working of the others.

At either end of the engine shaft, and directly next to the engines, a cut-off friction coupling should be provided. This is to insure against stoppage of the whole plant, if accident should occur to either engine. By this means one engine can continue to do the work.

Without extending these remarks too far, it is proper to add that numerous experiments have proven that better engineering expedients lie within the limits of the larger diameters for shafting, which secures rigidity from the known fact that the flexibility of the smaller shafts usually employed on the score of economy creates more friction by being drawn "out of line" by the pull of the belts in action upon the dynamo.

Again, with regard to the question of perfect regulation of engines. A single engine running at a slow speed will not produce, relatively, as equable a motion as a single engine running at a high speed. To effect regular motion with slow running engines, it is necessary to employ them in pairs, with their cranks set at right angles. Even then the results attained will be no more satisfactory than that effected by a high-speed single engine.

There is a normal speed for every build of engine. It is very certain that an engine made for low speed will not run at a high speed without injury to itself, and possible destruction; but we have abundant testimony proving high speed in engine work to be a pronounced success.

It involves, of course, many of the less-known elements of design and construction, and ever and always the best of materials, workmanship and attendance; all of which, however, are within the reach of modern shop practice, as they are of moderate price.

If proper care be taken in the selection of steam motors after intelligent examination of such as are already in use; if particular attention be given also to the installation and management of the whole plant; and if no part or parcel thereof be accepted, believing it to be the cheapest in the end, because its first cost is least, then will the production of electricity for lighting and other purposes make great and permanent advances.

* Page 261, "Fundamental Ideas of Mechanics."

REVIEWS.

A Practical Treatise on Electricity, comprising its Applications to the Sciences and to Industry, especially to Physiology, Medicine, Telegraphy, Electric Lighting, Galvanoplastics, Meteorology, &c. (Traité Pratique d'Electricité comprenant les Applications aux Sciences et a l'Industrie.) By C. M. GARIEL, Member of the Academy of Medicine, Chief Engineer of Bridges and Highways, Associate of Physics to the Faculty of Medicine of Paris, Professor of Physics and Chemistry to the National School of Bridges and Highways. Vol. II., with 347 figures. Paris: Octave Doin.

In the first chapter of this volume, devoted to chemical actions and currents, the author describes and figures the oxide of copper battery of De Branville

and the gelatinous battery of Guérin with the "folded" and felted accumulators of Simmen. Various electro chemical operations are then described, such as the electrolytic deposition of metals, refining, electro-metallurgy, electrolytic analysis, a subject which is here discussed too briefly to be of any practical value; electric bleaching, as shown at the Antwerp Exhibition by Scrive, Hermite & Co., a process which may possibly have before it a great future if means can be devised for reducing the working cost.

The method devised by MM. Naudin and Schneider for removing from commercial distilled spirits the aldehydes and deleterious "higher" alcohols by electric action is noticed as practically successful. We are glad to mention that the author does not, like some of his countrymen, apply to this process the singularly inappropriate name of "disinfection."

Prof. Goppelsroeder's schemes for the manufacture of colours and for dyeing and printing by electric action are next described, but M. Gariel prudently abstains from expressing any opinion as to the probable industrial value of these inventions.

The chemical action of the "effluve," or silent discharge, a subject which requires much further investigation, concludes this chapter.

In the second chapter the author takes up at much greater length "thermic actions and currents." Under this head he describes Clamond's thermo-electric battery, thermo-electric needles, the electric thermometers of Becquerel, Siemens and Sabine, the bolometer of Langley, the electric arc, the electric crucible of Siemens, a variety of incandescence lamps, one of which is specially devised for studying fermentations, Hélot and Trouvé's photophore, and a number of regulators.

The third chapter, entitled "Mechanical Actions and Currents," treats of the applications in which the electric current produces a mechanical effect. This chapter and the following on telegraphic and telephonic systems and that on indicators, registering devices and regulators, are, of course, devoted to arrangements the principles of which are well known to all persons even moderately versed in electrical science. It will soon become an exceedingly difficult thing to write a work on electricity until some capital discovery has modified the basis of the science or some novel application has opened up fresh fields to the reading public.

The leading phenomena of atmospheric electricity are fairly described, with the necessary admission that their laws are very imperfectly known and their causes still less so.

Much the same is said concerning the electric phenomena which have their seat in animals and plants. The author describes the application of static electricity and of currents in physiological research and in medical practice. A very full account is given of the galvanic cautery and of the use of electricity as a means of diagnosis.

For all persons who wish for a clear survey of the entire field of electricity this work may be decidedly recommended. The figures are well executed and appropriate, many of them being borrowed from our esteemed contemporary *La Lumiere Electrique*.

The Telephone in York.—In our notice of the Sanitary Exhibition at York last week, we should have mentioned that the National Telephone Company had an installation of telephones in the exhibition buildings, by means of which the subscribers to the York Exchange were enabled to listen to the concerts which took place daily. Visitors were permitted to make use of the telephones distributed in different parts of the exhibition, and of this permission they largely availed themselves. The York exchange was opened last December, and there are now 36 subscribers. A trunk line will shortly be laid to Leeds, when communication may be carried on with any of the principal towns in Lancashire, Cheshire, and Yorkshire.

NOTES.

Electric Illumination for Light Ships.—At the meeting of the Mersey Docks and Harbour Board on Thursday last week, the Marine Committee submitted various recommendations as to the lighting of the channels at the entrance to the Mersey. Mr. Holt, in moving the confirmation of the recommendations, said the first improvement suggested was the adoption of gas buoys, one of which it was proposed to place on each side of the Crosby Channel, about mid-distance between the Rock Lighthouse and the Crosby Light-ship, one having a flashing and the other a fixed light, the illumination being compressed gas. The commmittee also recommended the board to apply to the Trinity House to sanction an alteration in the lighting of the north-west ship. The board proposed to make a new bar ship with electric lighting. The old oil lights, owing to the increased power of steamers' lights, have occasionally been confounded with them. In the experiments they made, they were driven, rather against their will, to use a revolving light flashing twice a minute, and that would be definite enough so long as the electric light was maintained, but in case it failed and was replaced with the oil light it became identical with the light of the north-east ship, which was only eight miles off, and in the direct path of inward bound ships. They, therefore, recommended the board to ask the Trinity Board for permission to change the character of the light of the north-east ship from a light flashing twice a minute white and once red. The electric light on the bar ship would be the first floating electric light of the kind ever introduced, and he hoped it would be a great success. The proceedings of the committee were confirmed.

Electric Light Fittings.—Messrs. Faraday and Son have appointed the Vitrite Co., of New York, agents for the sale of their electric light fittings in the United States. The same firm has just introduced a new shade of rice paper of delicate tints, to suit the Vitrite lampholders. These, with their frames, cost but a fraction of the price of the ordinary glass shades.

The Lighting of Peter Robinson's.—Mr. Ernest G. Craven, A.M.I.C.E., is carrying out a very large electric lighting installation in the well-known establishment of Peter Robinson, of Oxford Street and Regent Street. The plant at present will comprise two Marshall's 20 H.P. nominal compound engines, three dynamos for arc lighting by Paterson and Cooper, and one Edison-Hopkinson machine for incandescent lighting. The lamps consist, in the two establishments, of 450 incandescents and 56 arcs of the Pilsen type. Another engine and boiler, and another Edison-Hopkinson machine, will eventually be put in position, and when completed it is expected that this installation will rank amongst the finest in the metropolis. The contractor must be ready for lighting up by the 17th of November, rather a short notice, when it is considered that the work was only commenced about 10 days ago. We wish Mr. Craven success in his undertaking.

Electric Lighting at Halifax.—Blakey, Emmott and Co., Limited, have secured the contract for lighting up the Halifax Industrial Society's extensive premises in Northgate, Halifax, by arc and incandescent lights.

The Electric Lighting Act.—Mr. George Offor has written to the papers discussing the difficulties the electric light industry has met with in this country, and the need for serious modifications in the Electric Lighting Act. One difficulty he refers to is "the unfortunate conflict between patentees, which causes an enormous waste of money and energy, besides frightening the public, who are threatened with proceedings if they use any apparatus but that made by 'the only Jones.'"

Church Lighting by Electricity.—The church of St. Anne, Chasetown, near Walsall, which was built by the munificence of the late Mr. J. R. M'Clean, M.P., together with the national schools, are now supplied with the Edison-Swan electric light. This has been done by the Cannock Chase Colliery Company, by means of its powerful dynamo, which has been long used for mining purposes.

Ship Electric Lighting. — The large steel screw steamer *Ormuz*, lately built for the Orient Steam Navigation Company, Limited, and launched from the Fairfield Shipbuilding and Engineering Company's yard, Glasgow, is to be fitted throughout with the electric light, along with all the modern improvements, including the largest triple expansion engines that have ever been constructed. The iron screw steamer *Australind*, launched from the yard of Messrs. Blackwood and Gordon, Port Glasgow, and designed for trading between Singapore, Java, and Western Australia, is also to be fitted throughout with the electric light, which is expected to add much to the popularity of the steamer. The latest addition to the magnificent fleet of the Peninsular and Oriental Company, the *Orinoco* just launched from the yard of Messrs. Caird & Co., Greenock, is to have the "light of the future" fitted throughout.

The Edinburgh Exhibition. — On Saturday night last some malicious person cut the wires which carry the electric current from the generators to the arc lamps which light the grounds of the exhibition. In consequence the grounds were in darkness with the exception of the promenade on the north side. This is the second time the same dastardly act has been committed.

The Oldest Installation in Existence.—It is said that the Paris Hippodrome claims the honour of having been lit by electricity for the longest consecutive period on record. The installation dates back to the year 1877, when four "Serrin regulators" were first permanently installed. Each of these lamps was supplied from a separate Gramme dynamo in the manner then practiced. From time to time the number of arcs has been increased, but, strange to say, the primitive arrangements have not only been retained but positively extended, so that at the present time there are no fewer than *seventeen* "Serrin regulators," each with its separate and distinct Gramme machine! These arcs do not, however, by any means represent the entire installation. There are employed in addition 133 Jablochkoff candles and over 1,000 incandescents. The current for the Jablochkoffs is supplied by seven alternating Grammes, for which four exciters are employed. Three additional direct current Grammes supply a portion of the incandescents, and the remainder are provided for by two Edison machines, each supplying 400 8-C.P. lamps at 110 volts. The total number of dynamos is thus no less than 33. All these machines are driven from one counter-shaft by cotton belting; the counter-shaft is driven in turn by two engines running at 180 revolutions. The machines are mounted on sliding frames, provided with screw adjustment.

Police Telegraphic System.—According to the recent report of the committee appointed to enquire into the condition of the Metropolitan Police Force, immediately after the riots of the 8th February steps were taken by the Secretary of State to place the postal telegraph system in communication with the police system, and a plan has been adopted by which a policeman on duty can, if occasion arises, demand "urgency" at the nearest postal office, and have any message transmitted at once to the General Post Office and thence to Scotland Yard. The report says :—"It appears to us that the police telegraph system ought to be still further elaborated, and with this object we asked Sir C. Warren to submit a paper stating his requirements; we agree as to the necessity of the changes he recommends, and urge their immediate execution."

Telegraph Revenue.—The receipts on the telegraph service from April 1st to September 30th, 1886, amounted to £940,000, against £935,000 received from April 1st to September 30th, 1885.

Telegraphists' Classification. — The Postmaster-General has replied to the telegraph clerks of the London Central Telegraph Office, in answer to their petition for a better scale of pay. He sees no reason for disturbing the classification of 1881, by which the staff of the Central Station received considerable benefit.

West African Cables.—We are informed that the cable steamer *Dacia* returned to the moorings off Silvertown on Sunday last, after successfully completing her work on the West African coast.

The Mackay-Bennett Cables.—According to a *Times* Philadelphia telegram, Western Union telegraph shares advanced to 78¼ on Monday, closing at 78, on the strength of a report that the Gould interests had acquired the control of the Mackay-Bennett Atlantic cables. This rumour was held to foreshadow an advance of cable rates, the Anglo-American lines being leased by the Western Union Company.

In reference to this matter the *Financial News*, invariably well-informed on American matters, says :—"Both Mr. Mackay and Mr. Bennett have positively declared that their cables are not in the market, and if Jay Gould did get them it is hard to see wherein they would add to the value of Western Union. The only practical effect of the deal would be to add another million dollars or more to the fixed charges on the omnivorous corporation. When Jay Gould laid his own cables four years ago he lost no time in saddling them on Western Union. They were capitalised at $14,000,000—about double their actual cost to the syndicate, and on that sum Western Union bound itself to pay 5 per cent. per annum, or, say, $700,000. The Mackay-Bennett cables, if they could be bought at all, would certainly cost as much as Jay Gould's own cables did, for they are worth more, and they are a thorn in the side of the monopoly which it is not likely to get rid of for nothing. It is not probable that the Baltimore and Ohio Company will allow itself to be cut off from ocean traffic. Once before it had its plans prepared for laying a cable of its own, and that project would be revived if all the existing cables were to pass under the control of Jay Gould. There is but one consolidation possible in American telegraphy, and that is for Western Union to absorb all rival land lines, as well as all rival cables; it must be master on sea and shore, as it used to be. The probability of such a consummation needs no great amount of human wisdom to measure. The amalgamation of 1881 was an almost incredible feat both of ambition and audacity, but it would be a fleabite compared with a new amalgamation to-day. The Baltimore and Ohio system and the Mackay-Bennett cables would be a big mouthful beside the American Union and the old Atlantic and Pacific."

Havanah-Key West Cables.—We are informed by the Silvertown Company that Mr. Theophilus Smith, engineer-in-charge of the cable steamer *International*, telegraphs the completion, on the 4th inst., of the repairs to the duplicate cables between Havanah and Key West. These repairs give to the International Ocean Telegraph Company of America a practically new cable from end to end, as the part untouched by the *International* was laid during repairs carried out within the last two or three years. The type of cable employed is specially protected to withstand the corrosive action of the bottom on the sheathing, this action having been very destructive to the cables hitherto laid in this locality. Although more than ordinary care has been exercised in the laying, it is impossible to free this cable from the danger of damage from the hot pitch springs which are found on the north coast of Cuba in depths ranging up to 800 and 900 fathoms. The operations completed were of no ordinary character, as

a large proportion of the work has been carried out in the axis of the Gulf Stream where the current varies, depending greatly on the winds, from ½ knot per hour from the eastward to over 5 knots from the westward, the normal direction of the flow. Mr. Theophilus Smith has had the benefit of the local knowledge of Mr. M. L. Hellings, who is cable manager of the International Ocean Telegraph Company, and has either superintended or been present at every repair to this company's cable during the last 12 or 14 years. Mr. March Webb and Capt. Wilson-Barker, R.N.R., were respectively chief electrician and commander on board the *International*.

The Marchant Engine.—We would call attention to the letter just received from Mr. Albert H. Howard who has made prolonged tests for a business firm in America, with the engine which is a source of so much uncertainty amongst some of our engineers. Mr. Howard's qualification for the task may be judged when we state that he gained his knowledge of mechanical engineering in the well-known firm of Armington and Sims. He is also known in connection with the Wimbledon electric lighting experiments, and with the working of the Hochhausen system. It is gratifying to learn that the only difference between our results and those to which we now refer occur in the *second* place of decimals.

A Luxurious Boat.—The new steam pleasure yacht Alva, which is being built by the Harland and Hollingsworth Company for William K. Vanderbilt, is said to be rapidly approaching completion. The vessel will be the largest and probably the most elegant and costly private steam yacht in the world. The vessel is built entirely of the best quality of steel—both ribs and sheeting. She is 285 feet long over all, 252 feet on the load line, 32 feet 3 inches beam, and 21 feet 6 inches depth of hold. She is built for classification in the highest class of the English Lloyd's. She will be rigged as a three-masted schooner, with square topsail on the foremast. The accommodation for the owner and his friends will be forward of the machinery, and will be of the most luxurious description. The cabins will be fitted with mantels, fire-places, electric incandescent lights, electric bells, and every convenience to be found in the rooms of the most elegant mansions. There will be more than a dozen bathrooms and closets, the plumbing of which will be of the very best character, and air pressure will be kept on all the water tanks, so that water will run from the faucets with a strong head without requiring pumping. The carpets, upholstery, bedding, furniture, and all the fittings and furnishings will be of the most luxurious character.

Electrical and other Publications.—Messrs. Whittaker & Co. will publish shortly, in their "Specialists' Series," "On the Conversion of Heat into Work," by William Anderson, M.I.C.E., "The Telephone and its Practical Applications," by W. H. Preece, F.R.S., and Julius Maier, Ph.D. The same firm announce a new work on "Technical Education and Applied Science Buildings, including their Fittings and Sanitation," by E. C. Robins, F.S.A., &c., and a "Bibliography of Electricity and Magnetism," including the most important articles published in periodicals, &c., from 1876 to 1885, compiled by G. May and A. Salle, Ph.D.

Generalising Electricity.—M. Baïhaut, Minister of Public Works in France, has appointed a technical committee, consisting of Government engineers, and presided over by M. Lucas, chief engineer of bridges and roads, with a view to the application of electricity to railways. Signalling, electric bells announcing the trains, inter-communication of trains in motion, continuous brakes, &c., will be dealt with. M. Baïhaut, we are informed, has the laudable object of generalising electricity, and will shortly appoint similar special committees for the various public services.

Mr. Crookes's New Paint.—We mentioned a few weeks ago the invention by Mr. Henry Crookes of a thermometric red paint, which becomes darker as it is heated, but resumes its former colour on cooling down. A daily contemporary suggests that peppery Irish Members of Parliament, who are in the habit of being affected by the heat of debate, should be painted with a thin tell-tale streak of this pigment, so as to indicate when the discussion was growing at all warm!

A Valuable Contact Detector.—At the last meeting of the Glasgow Town Council, the minutes of the Statute Labour Committee of date October 1st contained a report from Mr. Paterson, the fire brigade superintendent, that from December 3rd, 1885, to February 3rd last the brigade was called out 15 times by the fire alarm wires coming in contact with other wires. About the latter date the contact detector, the invention of Charles Eggar, was fitted to all the street fire alarms. The result had been highly satisfactory. From February 13th to September 29th the detector had been the means of discovering 78 contacts, and had thus saved much useless running, and consequent tear and wear of horses and plant. In only two cases had the invention failed to detect contacts. Mr. Patterson added that he was of opinion that a substantial reward should be given to Mr. Eggar, as the right to its use by the magistrates and Council was secured, although the invention was now patented by the contractors for the fire alarm system. The committee agreed to recommend that Charles Eggar be paid the sum of £20 on condition that the use of the detector shall be secured to the magistrates and council in all time coming free of all cost, fees, or royalties. The minutes were approved of.

Portsmouth Telephone Exchange.—Considerable progress has been effected of late in connection with this exchange. The local superintendent, Mr. J. H. Sandy, has, owing to the increase of business, lately opened larger and more suitable offices at Cambridge Junction, Portsmouth, and in order to fully cope with the work the clerical staff has been enlarged. Fortunately, the Town Council have been extremely reasonable in the matter of overhead telephone wires; but, at the same time, many obstacles have arisen in opening up new routes, which are necessarily greatly in request just now, when, besides the exchange business, which calls into use 150 miles of wire, there are over 50 private lines belonging to the company in operation. Since the opening of the exchange the old switching apparatus has been superseded, and with the view of securing almost instant communication, the multiple switch has been adopted. In order to still further popularise the undertaking, arrangements will be made to keep the exchange open day and night (excepting on Sundays). The line running from the central office to the *Excellent* and *Vernon* in the Dockyard having been completed, Portsmouth can now boast of being the only town in the kingdom having telephonic communication between the business community of the town and the ships in harbour.

Telephonic Communication in the Isle of Wight.—Several private lines have been erected during the past few weeks in various parts of the Isle of Wight. At Newport communication has been established between three mills belonging to Messrs. Roach Brothers. If sufficient promises are received, it is proposed to connect Cowes with Newport, and open exchanges in each town.

Southampton Telephone Exchange.—The arrangements in connection with the above are now in full working order, and already seventeen business firms have been connected, while fourteen private wires are in operation. The borough police and fire brigade stations have been put gratuitously on the exchange. The central offices are at 88, East Street, where a derrick has been erected capable of fixing 400 wires.

Telephonic Progress at Bristol. — The exchange which is carried on by the Western Counties and South Wales Telephone Company at its headquarters, Bristol, continues to increase its prosperity, and we understand that nearly 400 subscribers have been enrolled.

Electric Night Signalling.—On Thursday night last week an electric semaphore signal, which has been erected on board the gunboat *Scourge*, tender to the *Defiance* torpedo ship, was thoroughly tested at Devonport with satisfactory results, the weather being extremely favourable for the experiments. The *Scourge* was anchored at some distance from Mount Wise station, where the Commander-in-Chief at Devonport, Admiral A. Phillimore, and Admiral Sir W. Dowell, were in attendance to watch the progress of the signalling. The gas semaphore at Mount Wise signalled the preliminary order to "begin exercises." The answer, "we are all ready," was signalled by the electric light being thrown on a semaphore painted white, and was read by means of telescopes, but with some little difficulty, owing to the smoke from the *Scourge* somewhat obscuring the light. The position of the vessel was consequently altered, and the further signals that were made on board were quickly read at the station. Afterwards a glow semaphore on board the *Scourge* was tried, but not with any great success.

Telephony v. Telegraphy.—According to *Nature*, the question of telephony *v.* telegraphy has been recently discussed by a well-known German electrician, Dr. Wietlisbach. The chief hindrance to the use of the telephone for long distances is, he points out, of a financial, not of a technical, nature. A telephone line 2,000 km. long costs considerably over a million marks. It is still possible to speak very well this distance ; but even supposing the line were in constant use day and night, the receipts must be 5 marks (say shillings) a minute to make it pay. In telephone work, however, the line is in use only a few hours daily ; hence a short conversation would cost at least 50 marks (£2 10s.). That is, of course, too dear for ordinary traffic. The telegraph works, with almost the same speed, more than ten times more cheaply. Thus the question as to rivalry between telephone and telegraph finds its settlement. The telephone, up to about 500 km. distance (say, 310 miles), will more and more displace the telegraph, and find an extension which the telegraph would never reach. But for greater distances the telegraph must keep the upper hand. Thus telephone and telegraph are really not rivals, but fitted to supplement each other.

A Monster Electric Clock.—The Standard Electric Time Company of New York has, according to the *Electrical World*, been engaged for some time past in preparing the mechanism, &c., for the largest clock in the world, one having a face 25 feet in diameter. This clock is to be put against the wall of a building at the corner of Twenty-third Street and Fifth Avenue, resting on a lower building at the junction of the thoroughfares. The works are composed of sixteen pairs of electro-magnets placed around a 6 inch gear wheel. At the face of each pair of magnets is placed an armature extending to the gear wheel. Every second the current from the main line to 252, Broadway brings into circuit 64 cells of a local battery, energising one pair of magnets and starting the wheel, the impulse then affecting each pair in rotation, and distributing the pull or load very evenly. The armatures controlling the movement of the gear wheel are adjusted so that there is no jump when they act, the clock running with a smooth steady action. There are three gear wheels which turn a long vertical rod ; a worm at the top of this rod works on a hollow gear wheel turning the hands of the clock. The dial is painted on the wall of the building, and the hands travel around in front of it as in the ordinary clock. This gigantic clock is intended to serve as an advertisement.

Fire at Telegraph Works.—Last Saturday morning, at an early hour, a fire broke out at Victoria Road, Charlton, on the premises owned and occupied by Messrs. Johnson and Phillips, telegraph engineers, considerable damage being caused to the smith's shop and the contents.

Gas Explosions.—Great excitement was caused in Pall Mall and the surrounding neighbourhood on Thurday night last week by a gas explosion at Waterloo House, Cockspur Street, belonging to Messrs. Halling, Pearce & Stone. Some repairs to the gaspipes had been made in close proximity to the meter. Immediately on the gas being lighted at 6 o'clock a loud explosion occurred in the basement, which had the effect of blowing out the windows in that portion of the establishment and on the first floor. Between 80 and 100 young women were employed in mantle-making in rooms on these two floors, but fortunately all escaped without serious injury. The door leading to the street could not be opened, and the women rushed to the windows in a frantic state to escape. Some escaped by means of a ladder, and the others were released on the arrival of the police, who smashed the door in. The explosion caused a slight fire, which was promptly extinguished. Considerable damage was done to the showrooms by broken glass.

A serious explosion of gas, resulting in loss of life, occurred on Monday afternoon at the Bridge House Hotel, London Bridge. A portion of the building at the rear of the ballroom on the third floor is undergoing repair, and workmen were engaged in pulling up the flooring in a recess adjoining the western window of the room. One of the men, employed at the hotel, carrying a lantern, had just pulled up a board in the floor when a loud explosion took place, and a flash of light set fire to the laths and woodwork around. Several stones on the roof were also dislodged, and one fell into the bye-street at the side of the hotel, and struck the driver of a goods cart, which had just been driven up to unload. The unfortunate man was hurled from the cart and terribly crushed by the weight of falling stonework. He was in a hopeless condition when picked up, and was removed to Guy's Hospital, where he died on the following day.

A gas explosion, which caused injury to three persons, and did other damage, occurred on Tuesday night at the Loughborough Junction Wine and Spirit Stores, Coldharbour Lane, Brixton.

City and Guilds of London Technical College, Finsbury.—The Old Students' Association of this college held its first annual dinner on Friday last at the Duval Restaurant, Strand. A distinguished company, numbering over 60, of members and friends interested in the welfare of this young and flourishing association was present, under the chairmanship of its first president, Mr. H. Newman Lawrence, and included Prof. S. P. Thompson, D.Sc., principal of the college ; Prof. J. Perry, F.R.S. ; Prof. R. Meldola, F.R.S. ; Prof. W. E. Ayrton, F.R.S. ; and Prof. H. Armstrong, F.R.S. of the Central Institution ; Mrs. Ayrton ; the Rev. T. J. Lawrence, M.A., L.L.M., Cambridge University Extension Lecturer ; Mr. Mercer, and others. The after dinner proceedings were most enthusiastic, the toasts of "The Technical College," proposed by the chairman and responded to by the principal, and "The Old Students' Association," proposed by Dr. Thompson and responded to by the President and the President-elect (Mr. A. Chatterton, B.Sc.), were especially well received. It is needless to say that with the gentlemen named above present many excellent speeches were made, and a most enjoyable evening spent. It was announced that the silver medal of the association for the best paper read at the discussion meetings was awarded to Mr. A. W. Slater for his paper on "Torpedoes." Such a cordial and enthusiastic gathering of professors and students, past and present, speaks well for the internal working of the educational system inaugurated and so well maintained by the City Fathers, and we heartily wish the Finsbury Technical College Old Students' Association continued and increased success.

Dangerous Telegraph Engineering.—An extraordinary accident was last Saturday reported from the Vale of Llangollen. The Government is laying a new telegraph wire from London to Dublin along the Holyhead road. The operatives are at present engaged in fixing the telegraph poles between Llangollen and Berwyn, where they have to contend with limestone rock, which has to be blasted in order to insert the poles. At one of these blasts a stone weighing 10 lbs. was hurled through the air over the railway, the River Dee, the canal, and the road, a distance of 400 yards, and fell upon the roof of the entrance lodge to Sir Theodore Martin's residence, breaking through the ceiling.

Business Notice.—Mr. A. E. Conti, whose name has frequently figured in our correspondence columns, has recently commenced an electrical engineering business under the title of A. E. Conti & Co., at Via Arsenale, Genoa.

CITY NOTES, REPORTS, MEETINGS, &c.

Direct Spanish Telegraph Company, Limited.

THE twenty-sixth ordinary general meeting of this company was held at Winchester House, Old Broad Street, on Thursday, last week, Sir James Anderson presiding.

Mr. Ch. Gerhardi, the manager, having read the notice convening the meeting,

The Chairman reminded the shareholders that at the last meeting he spoke of the necessity of lifting the original Bilbao cable. It had since been picked up, and was now being overhauled with the view of getting what they could for it. The expenses of the past half year had been less than those of the corresponding period of the previous year by £189; while, as regarded the reduced tariff, after three months' trial, they were only £56 worse off as compared with any other three months.

Mr. Edmund Etlinger seconded the motion.

The Chairman, in answer to questions, said that the work of lifting the old Bilbao cable had been done by the Eastern Company at cost price—about £7,000. It was not all in the present accounts. The cost of the cable in question, including its removal to Santander and its subsequent re-establishment at Bilbao, stores, &c., had been £126,000; but that was when cables were dearer, and when something had to be paid for concessions and to promoters. About 150 miles of the old cable had been picked up.

Mr. Bannatyne said he did not agree with the passage of the report in which the directors said:—"They enclose a special report on the financial steps which are requisite to be taken in consequence of the loss of this cable as an asset." He was prepared to maintain that those steps were not necessary.

The Chairman said that to meet Mr. Bannatyne's objection they would substitute the words "they deem" for the word "are" in the passage quoted.

This alteration having been made, the report (which was published in the REVIEW for September 24th) was adopted.

The meeting was then constituted extraordinary for the purpose of considering a proposition to reduce the capital.

The Chairman said he expected the directors' proposal to reduce the capital would be severely criticised. He had himself thought that by giving the preference shareholders a little more than the ordinary shareholders the consent of the former might be more readily obtained. They had, however, been told—and they had found plenty of reason for seeing its force—that in a winding up the ordinary shareholders, who held two-thirds of the whole of the capital, would receive two-thirds of the assets. The preference shareholders had only a preference upon the revenue or the dividend. Without the consent of the ordinary shareholders they could make no adjustment of the capital. His own idea had been that if they could have given the preference shareholders £6 a share instead of £5 the scheme would have been easier to carry through, but certain large and important holders of the ordinary shares had stated that they would not agree to that. After fully considering the matter and taking advice from all useful sources, the board came to the conclusion that there was nothing better to advise the shareholders than to accept the plan submitted. An argument had been advanced by some shareholders in letters to the directors that if the dividend were reduced on the preference shares from 10 per cent. to 7 per cent. the proposal would have been more equitable. That view was not legal, and they were advised that they could not carry it. The object of the directors was to make the undertaking a living one, and if their proposal were carried and they went on prosperously the market value of the shares would be improved, the investment would be made a sound one, and they would have their capital represented by assets, with a reserve fund at the back of it. One shareholder had written asking why the directors wanted to lay another cable. They did not, however, wish to do so, but they desired to have the money in hand to lay another cable should it be necessary to do so hereafter. They estimated the life of the Barcelona cable at 25 years and that of the new Bilbao cable at 20 years, and 12 years of the former and 17 of the latter had still to run. As nothing had been set aside to a reserve fund hitherto these calculations required that they should lay by £5,000 a year. They had had one letter telling them that the company was to be sacrificed to the Eastern Company, but he was sure that the writer would not have said so if he had had sufficient knowledge to guide his judgment. He believed that but for the joint purse arrangement with the Eastern Company their own company must, on the breaking of the cable especially, have gone into liquidation, or if the concern had had to be "set on its legs" it must have been at a dearer price than was now proposed by the directors. With that plan adopted he believed the company would become a sound, paying concern; but the scheme did not provide for any amortisation of debentures. They must trust to the growth of the traffic for that purpose. He concluded by moving a resolution reducing the capital, in consequence of the abandonment of the original cable, from £190,000 to £95,000 by writing off £5 per share on both issued and unissued shares.

Mr. Etlinger seconded the motion.

The Solicitor, in reply to Mr. Cochrane, said that seven days' notice was sufficient for any meeting of the company. The Act under which they were proceeding was passed only ten years ago, and it was not very clear what precise power there was in any individual case to object to the steps taken. The directors anticipated that that point might be raised when they went before the Court for power to reduce the capital, and they would not be sorry if that were done, as it would save them from anxiety in the future.

Mr. Bannatyne opposed the scheme as unjust, inequitable, and illegal, and said he should take all legal means to defend his rights to a dividend of 10 per cent. on his £10 preference shares. He admitted that if the company went into liquidation the preference shareholders would get only a *pro rata* distribution of assets, but no Court, he contended, would authorise the liquidation of a company in their position, as shown in the report.

Mr. A. J. Baker also opposed the proposal, which he considered inequitable, favouring the ordinary shareholders at the cost of the preference shareholders. If the £1 a share liability on the ordinary shares were called up and added to the £10,000 at the credit of the reserve fund there would be £23,000, and another £50,000 would lay a new cable to replace the one lost. If that were done, the position of the preference shareholders would be far better.

The Chairman, in reply, stated that when Mr. Bannatyne was chairman of the company no provision was made against the breaking or the deterioration of the cables.

Mr. Bannatyne dissented.

The Chairman, continuing, said that when he joined the company there was not £1,000 at the credit of the reserve fund. The position of all interested in the company would, he maintained, be improved by the adoption of the plan now submitted, which was the result of 12 or 18 months' consideration on the part of the directors.

The motion was then put and declared carried by 17 to 5, the meeting terminating, after a vote of thanks had been accorded the chairman.

Submarine Cables Trust.—It is notified by the Submarine Cables Trust that a payment of £2 10s. will be made on account of the coupon due on the 15th inst., on and after that date, by Messrs. Glyn, Mills & Co. Coupons must be left five clear days previous to calling for payment. They will be stamped with the words, "£2 10s. paid," and returned to the holders. Due notice will be given when the trustees have sufficient money in hand to pay the balance of 10s. per coupon.

The Eastern Telegraph Company, Limited.—This company announces the payment on the 14th inst. of a dividend of 3s. per share on the preference shares, less income tax, for the quarter ended September 30th, and an interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended June 30th.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of September was 2,675, estimated to produce £2,230, against 2,585 messages, producing £2,160 in the corresponding month of last year. The receipts for the month of June estimated at £2,775, realised £2,767.

The Great Northern Telegraph Company, Limited. The receipts for September, 1886, were £25,600; from January 1st to 30th September, 1886, £195,560; in the corresponding months, 1885, £217,240; and of 1884, £208,680.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of September, 1886, were £1,751 against £1,793 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for September amounted to £30,107 against £41,845 in the corresponding period of 1885.

The Eastern Telegraph Company, Limited. The receipts for September amounted to £40,778, against £47,849 for the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending October 1st amounted to £4,375.

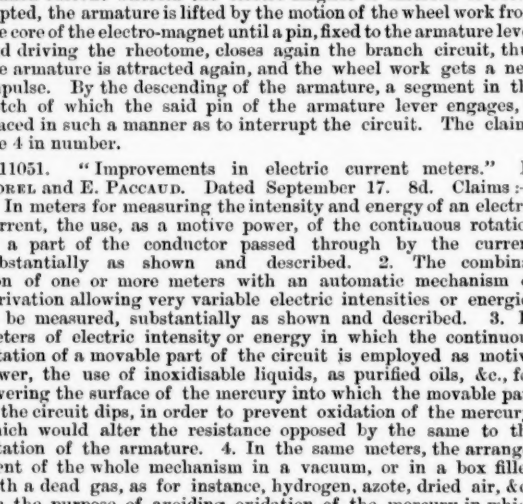
ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

9741. "Improvements in means and devices for telegraphic and telephonic purposes." A. M. ROSEBRUGH. Dated April 15. 1s. 1d. The inventor makes use of telephonic instruments having double coils, some of them wound or connected differentially, others wound or connected non-differentially, the two portions of the coils being respectively inserted in the outgoing and returning wires of a single metallic circuit. The differentially-connected instruments at one end speaking to the differentially-connected instruments at the other end, and the non-differentially connected instruments at one end operating simultaneously to the non-differentially connected instruments at the other end, without interference of the differentially and non-differentially connected instruments the one with the other. The claims are 11 in number.

10257. "Improvements in apparatus for measuring and registering electric currents." A. G. BROOKES. (Communicated from abroad by J. L. Huber, of Hamburg.) Dated August 29. 8d. Relates to improvements in apparatus for measuring electric currents, and more especially to that class of apparatus as described in the provisional specification filed with the application for patent dated July 23rd, 1885, No. 8,923, and the objects of the improvements are to make such apparatus independent of its position and of any outside motions or shocks which it may be submitted to when placed in ships, cars, or other movable objects. Instead of moving by means of the intermitting motion of the armature lever, a charged lever for driving the wheel work in the manner described in the provisional specification of the said application, the movement of the armature is employed directly for winding up the driving spring of the wheel work. To this effect the armature of the electro-magnet is connected with a lever having its fulcrum on the axis of the friction or ratchet wheel. This lever is provided in the well-known manner with a ratchet or pawl, which engages into the said ratchet or friction wheel, and causes the same to be rotated intermittingly by alternate raising and lowering. As soon as the armature, in consequence of the electric current passing the electro-magnet, is drawn towards the core of the latter, the friction or ratchet wheel is rotated, and thereby winds up the spring of the spring-barrel connected with the wheel. But, as simultaneously by the descending armature the branch current wherein the electro-magnet is inserted is interrupted, the armature is lifted by the motion of the wheel work from the core of the electro-magnet until a pin, fixed to the armature lever and driving the rheotome, closes again the branch circuit, thus the armature is attracted again, and the wheel work gets a new impulse. By the descending of the armature, a segment in the notch of which the said pin of the armature lever engages, is placed in such a manner as to interrupt the circuit. The claims are 4 in number.

11051. "Improvements in electric current meters." F. BOREL and E. PACCAUD. Dated September 17. 8d. Claims:—1. In meters for measuring the intensity and energy of an electric current, the use, as a motive power, of the continuous rotation of a part of the conductor passed through by the current substantially as shown and described. 2. The combination of one or more meters with an automatic mechanism of derivation allowing very variable electric intensities or energies to be measured, substantially as shown and described. 3. In meters of electric intensity or energy in which the continuous rotation of a movable part of the circuit is employed as motive power, the use of inoxidisable liquids, as purified oils, &c., for covering the surface of the mercury into which the movable part of the circuit dips, in order to prevent oxidation of the mercury, which would alter the resistance opposed by the same to the rotation of the armature. 4. In the same meters, the arrangement of the whole mechanism in a vacuum, or in a box filled with a dead gas, as for instance, hydrogen, azote, dried air, &c., for the purpose of avoiding oxidation of the mercury in which the movable part of the circuit moves, as described.

11331. "An improved method of arranging the inducing and induced circuits of secondary generators employed for the distribution of electrical energy." L. GAULARD and J. D. GIBBS. Dated September 23. 6d. The inventors unite by a short circuit the poles, N and N^1, of the inducing and induced circuits, and they place between the poles, P and P^1, a resistance, S, of self induction, which by means of a movable core, T, of iron may be so varied as to determine in the derived secondary circuit feeding the lamps, the necessary difference of potential, the electrical quantity supplying this circuit being determined by its special coupling. Under these conditions, the two circuits, primary and secondary, of the secondary generator being metallically connected no static charge capable of interfering with the insulation of the primary and secondary spires is produced. Claim:—In secondary generators employed for the distribution of electrical energy, uniting the primary and secondary circuits or coils thereof, so as to prevent the production of static charge, substantially as and for the purposes described.



11501. "Improved telephones." S. P. THOMPSON. Dated September 26. 8d. Figs. 1 and 2 show in views at right angles to each other, a dynamo telephone on the magneto principle, the armature, A, being mounted to vibrate (on the pivot, a^5, mounted in any suitable supports) in front of the poles of a permanent magnet, B. There are two coils, a, on the iron cores, a^2, carried by an iron yoke, a^4, mounted on an elastic hub, a^3, and suitably

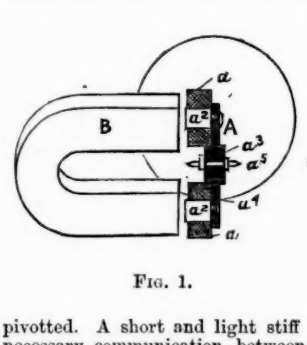


FIG. 1.

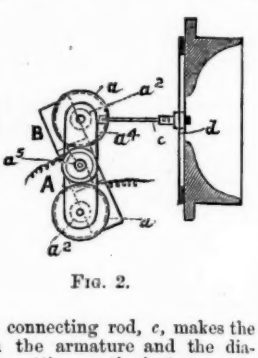


FIG. 2.

pivotted. A short and light stiff connecting rod, c, makes the necessary communication between the armature and the diaphragm, d. It is found desirable in setting up the instrument to give to the armature a slight lead with respect to the field-magnets. This has double effect, it causes any small change in position to have a greater influence on the magnetic field, and it also gives a mechanico-magnetic back attraction which serves to keep the diaphragm in a state of initial tension. The diaphragm may be of mica, celluloid, parchment, alluminium, or any metal, whether magnetic or not, its function being purely acoustic. Claims:—1. The instruments denominated dynamo telephones, having an armature, pivoted or equivalently supported in proximity to the poles of a field magnet, and connected to a diaphragm substantially as hereinbefore described. 2. In a telephone, the combination of an elastically centred armature with a field magnet substantially as described. 3. In a telephone, the combination of a ring-armature or drum-armature, or other pivotted armature, with a diaphragm, suitable for taking up the vibrations from the armature, and imparting them to the air, or for taking them up from the air and imparting them to the armature. 4. In a telephone, the combination of a ring-armature, drum-armature, or other pivotted armature, with a field-magnet, substantially as described. 5. The several arrangements described and illustrated by the several figures of the drawings.

11566. "An in and out electrical push indicator." N. G. THOMPSON. Dated September 29. 8d. The object of this form of indicator, is to indicate at the entrance of any building—if the person called on is in or out. The general arrangement will be as follows:—A board, on which is fixed the indicator in question as well as numerous contact breakers or pushes, is placed in the entrance of the building; each push on being pressed can form electrical connection through the indicator and a battery, and also through the indicator and by conductors, through a switch fixed in any room and back to another battery. There are, therefore, two circuits, and either one, or both, can be completed; but if the person to whom the push refers, has broken circuit by means of the switch placed in his room, then only one circuit will be completed. The effect of completing either circuit is to make a disc marked in or out as the case may be appear at the indicator hole. In some cases only one battery will be used, one circuit formed and half the indicator arrangement employed, and then the discs will only show blank and in or blank and out. Claims:—1. General arrangement of batteries, pushes, and room switches in conjunction with the indicator, either with a single circuit or double circuit, as described. 2. The employment of solenoids or magnets for actuating one, two, or more discs as specified. 3. The method of indicating and use of a stationary disc behind the movable discs or disc. 4. The employment of a differentially wound solenoid for actuating one, two, or more discs as specified. 5. The employment of a differentially wound magnet, actuating a permanent magnet in place of armature for effecting the same purpose as in claims 2 and 4. See REVIEW for July 23rd, 1886.

1886.

8376. "Improvements in Clark standards of electromotive force and other galvanic cells having mercury electrodes." A. MUIRHEAD. Dated June 25. 6d. Relates to the improvements described on page 301 of the number of the REVIEW for September 24th, 1886.

CORRESPONDENCE.

The Marchant Engine.

In answer to your editorial note, appended to the letter which you did me the honour of publishing last week, I beg to say :—

1. It would be rash, even "for the sake of argument," to *assume* anything about the horse-power of the Marchant engine.

2. I *can* point to engines which have done a horse-power on about 1½ lbs. of coal per hour ; but, whether I could point to such engines or not, it appears to me that the question under discussion is not affected in the least.

3. I "ignore" indicator diagrams because I have not seen them. Should they, when published, "bear out the data obtained by means of the brake," I will tell you what I think of them.

4. I await with confidence the report of the "experts ;" and, meanwhile, I would again call your attention to the end of the lever, L, which does not move about the axle as a centre.

Wm. H. Massey.

October 5th, 1886.

[We are glad to hear from such an authority as Mr. Massey that he has known engines develop one horse-power for the consumption of 1½ lbs. of coal per hour ; on the face of such a statement it certainly appears to be within the bounds of possibility that still further economy might be secured. It may be rash to *assume* anything about the horse-power of the Marchant engine, but is it not equally risky to *ignore* the existence of anything because one does not happen to have seen it ? As a matter of fact, the brake does turn about the axle as a centre. The little block under the lower half of the brake is not attached thereto, and as soon as the brake moves it lifts clear of the block.—EDS. ELEC. REV.]

In a letter in your last issue, with regard to the engine tests made some time before, the contention is made that the Prony brake used on the occasion showed more than the actual horse-power of the engine.

This contention is based on the assumption "that the end of the lever, L, does not move about the centre of the axle, but about some point near E, the rolling block." The actual movement of the lever, L, must be around the centre of the shaft, as the brake is clamped firmly to the pulley ; therefore the assumption probably means that the rolling block, E, constitutes another point of support for the brake.

If that were the case, and the brake were held at two points, viz., by the lever, L, and the block, E, the actual power given out by the engine must have been greater than that stated in the report, and not less, as suggested in Mr. Massey's letter. This follows naturally, as the pull in pounds on the point of support at the bottom must be added to the pull indicated by the Salter's balance, before the total strain exerted by the engine can be ascertained. This seems so evident as hardly to require proof. The total pull of the engine must equal the sum of the strains opposing this pull to keep the brake in a state of equilibrium. Therefore if the contention were true, the engine was giving out even greater power than that stated, with a correspondingly smaller consumption of coal per H.P. per hour.

As a matter of fact, the assumption is incorrect, and the horse-power given out is indicated exactly by the brake. The rolling block, E, in no way alters the pull on the balance, inasmuch as the entire brake moves through a small arc when the engine is started, and lifts the rolling block, E, slightly away from its support. This is easily seen by reference to the diagram on page 277.

I may mention that I have lately taken two independent tests of the Marchant engine, extending altogether over 9½ hours. I examined carefully the support of the brake and am satisfied that it could in no way increase the pull shown on the balance, and that the brake indicated correctly the horse-power of the engine.

Albert H. Howard.

114A, Queen Victoria Street, E.C.,
October 6th, 1886.

The following letter answers a question raised by Mr. R. E. Crompton in your issue of September 24th :—

Steam Engine and Boiler Works,
Bromley-by-Bow, London,
6th October, 1886.

William Downie, Esq.,
Managing Director,
The Marchant Engine Syndicate, Ltd.,
24, John St., Bedford Row.

Dear Sir,—In reply to yours, calling our attention to the remarks of Mr. Crompton as to whether there is any auxiliary supply of heat to the boiler now working the Marchant engine, we beg to state that, having reconstructed the boiler, and having also set it in its present position, *there is no other means* of supplying fuel or heat of any description to this boiler except in the ordinary way, *i.e.*, by means of the furnace doors.

Yours truly,
(Signed) FRASER & FRASER.

Mr. Marchant informs me that he has no recollection of ever having called on Mr. W. H. Massey in London or elsewhere, nor was he aware that there was such a person in existence until his attention was called to the letter bearing his signature in your last issue.

With your kind permission I shall hope shortly to place indicator diagrams before your readers, and in the meantime I beg to say that two protracted tests (one lasting over seven hours) have been made by an engineer specially appointed by several engineering establishments, and although I am not at the moment in a position to give his name, still I can say that the results fully verify the tables published in your issue of the 17th of September last.

William Downie, *Managing Director,*
THE MARCHANT ENGINE SYNDICATE, LIMITED.

Bourseul's Telephone.

I send to the REVIEW a correct translation of a full description of Bourseul's telephone, written by himself and published in 1854, preceded by the introductory remarks of the editor. Du Moncel and other writers have written a few sentences about this, the *first* telephone invented, but nowhere as yet has so full a description of it been published. I withhold for the present the name of the original publication, which *may* be used in the suit now pending against the Bell telephone patents.

In the REVIEW of August 20th last, p. 203, T. D. Lockwood, of Boston, an employé of the Bell Telephone Company, says : "I do not, for example, believe that because Bourseul had a dim vision of a speaking telephone in 1854, and described a Morse key and sounder operated by the human voice, he should be set up, as he is by Wm. C. Barney, as the inventor of the telephone."

Mr. Lockwood must have been ignorant of the description of Bourseul's telephone, or he certainly would not term Bourseul's "*movable plate, so flexible that it will not miss any of the vibrations produced by the voice*," to be a Morse key, which is simply a rigid bar pivoted and acting as a lever ; nor would he term Bourseul's *movable plate vibrated by electricity* to be a Morse sounder.

In support of my statement that the description of Bourseul's telephone furnished all the information necessary to make a magneto telephone, I cite the following extracts from a paper signed by Comte du Moncel, published in *La Lumière Electrique*, on 29th December, 1883, as follows :—

"*M. Bourseul avait donné une description très détaillée de son système dans le Journal l'Illustration du 30th Juillet*, 1854, *description qui ne laissait aucun doute sur les moyens qu'il mettait à contribution.*"

It has been repeatedly urged that if such a wonderful discovery had been made public, it certainly would have been put into practice ; but the fact that scientific men of that day did not appreciate nor understand the full scope of the wonderful invention is not evidence that the invention had not been made. Did not Comte du Moncel, in his *Exposé*, in 1857, treat the invention as "a fantastic idea of a certain M. Ch. Bourseul ?"

M. du Moncel has not given the correct date of publication nor the title of the publication.

In reply to all such cavilling, I quote the following words from the judgment of the Master of the Rolls, the late Sir George Jessel :—

"Though nobody knew how to make a receiving instrument, if we are told this is a telephone receiver that will give articulate sound, it would nevertheless be a publication, though nobody knew how to work it." And Lord Justice Bowen, in his judgment in the same case, said : "I can conceive an instrument being useless at the time when its use was not known, but which afterwards became useful."

The suit against the Bell patent has not yet been called for trial on its merits ; the counsel for the Bell patent has demurred to the jurisdiction of the Court, and this question has been argued before the Court in Ohio for the past four days. Several months ago I was so unwise as to send you my opinion on this question as well as on the merits of the case.

W. C. Barney.

Hotel Arno, New York,
September 23rd, 1886.

Welding by Electricity.

In your issue of the 17th inst. I read with much interest an article on welding by electricity, in which is described a method as carried out by Professor Elihu Thompson, of Boston.

I desire, with your permission, to draw attention to the fact that I applied, fully 18 months ago, the well-known principle that there is greater electrical resistance at a break than at any other portion of a conductor, and consequently increased temperature at this point, to effect the welding or fusing of wires together. Since then, I have repeatedly (as well as our workmen) fused or welded wires together for incandescent lamps. The practical application of this well-known fact, and one which commends itself to manufacturers and users of incandescent lamps, consisted on my part of welding the ends of broken platinum loops of incandescent lamps, by this means rendering otherwise useless lamps valuable. The apparatus I employ for performing this operation is more primitive than that of Professor Thompson, but the principle is the same. It consists in fastening to the whole loop of the lamp a flexible terminal of a dynamo (either alternate or direct) of sufficient electromotive force to render the (filament ?) incandescent. I then bring the ends of the defective loop in contact with each other, at this contact complete the circuit through the filament by touching the other terminal of the dynamo, I then break circuit at this contact and a welded or fused junction is effected.

The heat necessary to fuse the platinum is so completely localised to the joint that no damage is done to the glass of the lamp. The welding is more easily done with low than with high resistance filaments for the same size of wire, as is evident.

J. B. Duncan.

Newcastle-on-Tyne,
September 28th.

A New Scale for Tangent Galvanometers.

Regarding the letters of Messrs. Swinburne and Evershed, in your issue of this date, I think it is to be regretted that Mr. Swinburne did not publish his observations in 1882. The patents of Sir Wm. Thomson, to which reference has been made, do not contain any suggestion as to the use of a false zero to increase *the sensitiveness* (not the *range*) of the galvanometer, and it is not clear that Mr. Swinburne had this object in view in his investigations. An angle of 36° would be much less sensitive than that adopted, viz., 60°, while it would not be suitable for use with a new instrument (in use by the Post Office) for estimating *directly* without calculation, electromotive force and resistance per cell of a battery.

It might be also pointed out that with a 60° zero, a current which would deflect the needle so as to be parallel to the coil, would place the needle in a position of greater sensitiveness to small changes in current strength than if deflected 45° from the old zero in the ordinary way.

As Sir Wm. Thomson claimed the new scale at the British Association meeting before the new paper was read, and as his patents do not throw any light on the question, it may be assumed that some mistake exists. The question is not of sufficient importance to warrant any lengthened discussion, but should Mr. Swinburne be really quite clear as to the points involved, and still assert his priority, I shall have much pleasure in congratulating him, while regretting that publicity should not have been given to his investigations at the time.

I must emphatically protest against the statement that the possibility of using an ordinary tangent galvanometer on the skew principle is a fact which has been generally known for years ; if it had been known we should certainly have found such an important and useful fact referred to in more than one text-book ; but this is not the case. I would only add that Mr. Evershed is mistaken when he says that I admitted that the new scale was invented by Sir Wm. Thomson ; what I did say was that this was a claim made by the latter gentleman ; but, as I have stated, there appears to be some mistake on this point.

A. Eden.

October 1st, 1886.

The Skew Tangent Scale.

Can anyone tell me which of Sir W. Thomson's patents relates to the skew scale ? I was under the impression that I possessed all his specifications of recent years. I can find tangent scales amongst them, but not *skew* scales.

Subscriber.

Patents for Dynamos.

It is obvious that Mr. G. Bowron, whose letter you print on p. 343, has not seen the specification of my patent, about which he writes.

S. P. Thompson.

City and Guilds of London
Technical College, Finsbury,
October 2nd, 1886.

Electrical Formulæ.

Kindly permit me to point out two obvious errors which have somehow crept into my letter in your last issue. The poles of the cell, C, in the first sketch should be reversed, and the equation $v = 1{\cdot}072 \frac{G}{R + r} \cdot n$ should read $v = 1{\cdot}072 \frac{G}{R + r}$.

J. Pigg.

5, Pine Street, Newcastle,
October 4th, 1886.